6c. ADDRESS (*City, State, and ZIP Code*) Director, USAMSAA ATTN: AMXSY-LR Aberdeen Proving Ground, MD 21005-5071	7b. ADDRESS (*City, State, and ZIP Code*) U.S. Army TMDE Activity ATTN: AMXTM-P Redstone Arsenal, AL 35898-5400
8a. NAME OF FUNDING/SPONSORING ORGANIZATION USAMSAA — 8b. OFFICE SYMBOL (*If applicable*) AMXSY-LR	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (*City, State, and ZIP Code*) Director, USAMSAA ATTN: AMXSY-LR Aberdeen Proving Ground, MD 21005-5071	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT ACCESSION NO.

11. TITLE (*Include Security Classification*) Cost/Benefit Analysis of the AH-64 (Apache) Helicopter Automated Test Equipment (ATE)

12. PERSONAL AUTHOR(S) Pridgeon, Scott P.; Vogt, Ann T.; Waggoner, Larry P.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (*Year, Month, Day*)	15. PAGE COUNT
Final	FROM ________ TO ______	1992 January	

16. SUPPLEMENTARY NOTATION

19. ABSTRACT (Continued)

IFTE. Moreover, based on sensitivity analyses, the ranking of alternatives is unaffected by assumptions concerning fielding schedules, life cycle period, peacetime quantity requirements, dedicated vs. shared ATE support, replacement of non-tactical EETF's, retention of Apache peculiar equipment and inflation and discounting. In every case, the results show that retaining the EETF and continuing with the current computer upgrade is the lowest cost alternative. Sensitivity analyses comparing the costs of buying ATE in sufficient quantities to meet wartime requirements, however, show IFTE to be competitive or less costly than EETF.

Several issues were raised during the study and are addressed in the cost comparison and sensitivity analyses provided herein. Many of the issues directly impacted costs. Although relative costs changed to some degree, the ranking of alternatives was unaffected. Issues raised on the wartime support of workload were valid. However, to date, the Army has not supported procurement of ATE to support the wartime requirement for Apache. If a decision were made to procure ATE to the wartime requirement, IFTE would be the preferred system. Support of Apache by a generic electronic maintenance company was also addressed. According to the developer of the generic maintenance concept, Apache is specifically excluded from this support. Apache usage of current ATE workload capacity would have to be less than 40 percent to make IFTE competitive with EETF. Since the Apache is anticipated to require 70 percent of the available capacity, taking the sharing of excess capacity into account does not change the conclusions.

Transitioning to IFTE is feasible and there are benefits and advantages for doing so. IFTE with the S-280 shelter provides multi-system support; better transportability; nuclear, biological and chemical protection; technological advancements and enhanced user friendliness. However, there is limited space in the S-280 shelter for the electro-optics bench, Apache peculiar equipment, Test Program Sets and Interconnecting Devices needed for Apache. Disruption of the current maintenance support structure caused by pulling EETF's out of the field in order to install the IFTE Base Shop Test Station into the vans would be a major disadvantage.

In conclusion, the EETF with the computer upgrade is the least cost approach for the peacetime support of Apache. If, however, Army policy were changed to buy ATE to wartime requirements, then IFTE would be the preferred alternative.

ACKNOWLEDGEMENTS

The U.S. Army Materiel Systems Analysis Activity (AMSAA) recognizes the following individuals for contributing to this report:

Peer Reviewer: George Nielsen, Air Warfare Division

The authors wish to acknowledge Wilson E. Heaps, Chief of the Resource Studies Branch, AMSAA, for his assistance and guidance in the conduct of this analysis.

The authors also wish to recognize the following individuals for their assistance in providing data and information used in this analysis:

Dan Raleigh and Clay McDowell, LRAD; Paul Yurechko, CSD, AMSAA;
LTC Chester Rees and Pam Brady, PM Apache ATE;
Bill Washington and Ron Weinland, PM-TMDE;
Linda Johnston, CECOM;
Jan Hamilton, Lynn Divoll and Don Wilson, OMMCS; and
Bill Mueller and Herb Gray, AVSCOM

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CONTENTS

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

COST/BENEFIT ANALYSIS OF THE AH-64 (APACHE) HELICOPTER AUTOMATED TEST EQUIPMENT (ATE)

1. INTRODUCTION

1.1 Background.

In April of 1986, the Army Materiel Command (AMC) established a policy that the Integrated Family of Test Equipment (IFTE) would be the standard Automated Test Equipment (ATE) for Army electronic equipment. Any system which plans to use alternative ATE after Fiscal Year (FY) 92 must seek a waiver from the Program Manager for Test, Measurement, and Diagnostic Equipment (PM TMDE) in accordance with Army Regulation 750-43. This waiver request must include a cost/economic analysis comparing use of the IFTE versus the proposed ATE alternative.

The Electronic Equipment Test Facility (EETF) has been and is currently being used to fault isolate the AH-64 Apache line replaceable units. Early in 1988, it was decided that, in order for this to continue, a cost/economic analysis had to be performed. The Product Manager (PM) for AH-64 Apache ATE requested the U.S. Army Materiel Systems Analysis Activity (AMSAA) to perform the study. This analysis was documented in November of 1988 (reference 1). The study recommended transition to IFTE because the differences in life cycle costs (LCC) of the alternatives (IFTE versus EETF) were insignificant and the benefits derived with IFTE were expected to be greater. The LCC differences were well within the margin of error (less than five percent). The benefits of standardization, user enhancements, greater availability and adaptability all favored the IFTE. Further details concerning this study can be obtained from the referenced report.

According to the minutes of the TMDE/Aviation Ground Support Equipment laydown briefings, held 1 October 1990, there is a shortfall of funding for IFTE (reference 2). The current funding allows for procurement of sixty-eight percent of the IFTE requirements through FY96. Also, the Electro-Optic (EO) portion of the IFTE remains significantly underfunded. Failure to adequately fund the program will require the use of EETF beyond the time-frame for which it is envisioned.

There are currently several problems with the EETF. The EQUATE Core-410 computer, configured with 1960's technology, is quickly approaching obsolescence and is contributing to long run times, throughput problems, and supportability problems. The Engineering Change Proposal (ECP) 185(R)2 is a replacement for the Core-410 computer control and display subsystems and is being incorporated to solve these problems. The decision was made to continue the use of EETF with the ECP185(R)2 as an interim solution. This updated EETF, with the ECP185(R)2, is the EETF which is referred to throughout the remainder of this report.

As a result of the issues mentioned above, the Commanding General of AMC requested that another economic analysis of EETF versus IFTE be performed. The purpose of this task is to determine, based on the latest information, whether the Apache should transition to IFTE or continue with the EETF.

1.2 Systems.

The EETF is composed of the ATE, two 35-foot vans (an expansible test van and a support storage van) and two diesel generators. The vans can be pulled by two five ton trucks. The expansible test van contains the ATE necessary to test and diagnose faults for 80 designated Apache Line Replaceable Units (LRU's). It currently contains the Electronic Quality Assurance Test Equipment (EQUATE) AN/USM-410 core computer (hereafter referred to as the Core-410) control and display test station, certain Apache Peculiar test Equipment (APE), and an Electro-Optics Bench (EOB). The Core-410 computer has been upgraded, under ECP 185(R)2, with more current technology equipment. Incorporation of this ECP was directed by the PM-TMDE as a cost effective measure. This upgrade is currently being fielded. The EOB is used to fault isolate all Target Acquisition Designation Sight/Pilot Night Vision System (TADS/PNVS) LRU's. The APE consists of several items of equipment which are peculiar to the support of Apache (see Appendix A for details). The storage van contains the Test Program Sets (TPS's) and InterConnecting Devices (ICD's). The five-ton trucks come from unit assets and are not dedicated.

IFTE has been identified as the standard ATE for fault isolation of Army electronic equipment. It is intended to reduce test equipment investment costs as well as recurring sustainment costs. The basic IFTE consists of a Base Shop Test Station (BSTS) housed in an Army standard S-280 shelter and transported on a five ton truck. The TPS's and ICD's are housed in a second S-280 shelter also transported on a five ton truck. Currently, the basic IFTE does not have an electro-optics test capability, but an EOB developed by the Navy is under consideration.

Detailed configurations of the EETF and IFTE equipment are described and illustrated in Appendices A and B, respectively.

1.3 Objective.

The objective of this analysis is to compare the costs, benefits, and feasibility of continuing to use EETF versus various options for transitioning to IFTE in support of Apache. This analysis is to be an update of the 1988 AMSAA study, based on the latest information available for the two systems. In order to satisfy this request, a life cycle cost analysis is conducted in which alternatives are compared over a 20-year time frame. Because of the lack of data required for quantification, the benefits of using IFTE in support of Apache and the advantages and disadvantages are only minimally addressed in this report.

1.4 Issues.

There are several issues that are considered in this study. In these days of limited resources and an ever-shrinking Defense budget, the main issue is cost. What are the total life cycle costs attributed to each alternative and what are the funding requirements of each? The other issues, considered relevant to the study, also impact cost. The first issue is system requirements. Because the IFTE is to be a faster running system than the EETF, thereby improving LRU throughput time, will the same number of IFTE's be

required as EETF's to support Apache? Will the support structure required to maintain Apache allow for fewer IFTE's? Will there be any differences in the level of support needed for the three different versions of Apache? If so, how will this affect the requirements? The next issue, scheduling, concerns the fielding of several different pieces of equipment and TPS/ICD conversions. Specifically, during what time frame will the ECP185(R)2 be installed in the EETF's? When will IFTE be available? How long will it take to complete TPS/ICD conversions? Training inputs and the requirement for a special Military Occupational Specialty (MOS) for EETF is another issue investigated. If EETF is continued, what effect will it have on both the training base and cost? The final issue concerns the software and hardware required to test individual LRU's. What will be the costs involved in converting the EETF TPS's and ICD's to run on IFTE? All of these issues are addressed in the study and are discussed throughout the course of this report.

1.5 Scope.

This study focuses on the thirty-six EETF's that the Army has procured for the support of Apache. Twenty-two of these EETF's are in tactical configuration and fourteen are in special purpose floor-mounted configuration.

All except two of the tactical units are used by the Aviation Intermediate Maintenance (AVIM) level to fault isolate LRU's. These EETF's are mobile, mounted in vans, and powered by generators which make them a full-up, self contained configuration.

Table 1 shows the distribution of tactical EETF's across AVIM's and locations (references 3 and 4). The number of units supported by the AVIM and the quantity of Apaches belonging to the units are also shown. When the full complement of Apaches are procured, these EETF's will support a total of 807 aircraft consisting of versions A, B, and C.

Table 2 lists the fourteen floor-mounted EETF's. These EETF'ls are not mobile and are not assigned to AVIM units. The first column lists the number of EETF's located at the sites listed in column three. Column two indicates the number which have an EOB for use to develop and test EO TPS's, and to test TADS/PNVS LRU's. Only three of the floor-mounted EETF's have an EOB. The last column indicates how these systems are used (reference 4).

Table 1. DEPLOYMENT OF TACTICAL EETFs

No. of EETF	AVIM	Location	No. of Units	No. of Acft
1	TBD **	On Lease to Israel	-	-
1	OMMCS ***	Redstone Arsenal, AL	-	-
1	Dir of Log	TRADOC - Ft. Rucker, AL	-	68
1	I Co 158 Avn	III Corps, Ft Hood, TX	3	54
1	K Co 158 Avn	III Corps, Ft Hood, TX	2	36
1	I Co 159 Avn	XVIII Corps, Ft Bragg, NC	1	20
1	H Co 159 Avn	XVIII Corps, Ft Cmpbl, KY	2	37
1	K Co 159 Avn	XXIII Corps, Ft Stwrt, GA	1	18
1	F Co 1 Avn	1 Inf Div, Ft Riley, KS	1	18
1	F Co 4 Avn	4 Inf Div, Ft Carson, CO	1	18
1	F Co 5 Avn	5 Inf Div, Ft Polk, LA	1	18
2	A Co 7-159 Avn	VII Corps, Illesheim, GE	7	126
1	A Co 8-158 Avn	V Corps, Weisbaden, GE	2	36
1	B Co 8-158 Avn	V Corps, Hanau, GE	3	54
1	MS AVCRAD	NGB, Gulfport, MS	3	45
1*	70th Trans Bn	7th Army, Backup to V & VII Corps		
1*	B Co 3-501 Avn	8th Army, Korea	2	36
1*	MO AVCRAD	NGB, Springfield, MO	2	30
1*	CA AVCRAD	NGB, Fresno, CA	7	105
1*	7-6 Avn	5th Army, Conroe, TX	2	30
1*	TBD **	USAREUR, VII Corps		
22		Additional APACHEs		58
				807

* Not yet fielded.
** TBD - To be determined.
*** Not to be replaced.

Table 2. FLOOR MOUNTED EETFs

# EETFs	with EOB	Location	Use
2	1	McDonnell Douglas, Mesa, AZ	Post deployment software support
3	0	General Electric Burlington, MA	Software support, spares sell-offs, engineering, depot maint on core 410
2	1	Martin Marietta, Orlando, FL	TPS development, TPS changes
1	0	LSSI, Ft Hood, TX	Apache training brigade support
2	0	Hellfire PM, Redstone & Anniston, AL	Hellfire support
1	0	Communications-Electronics Command	Core 410 software support
1	0	Tobyhanna Army Depot	Transition from contractor to organic support
1	1	Corpus Christi Army Depot	AVIM capability for depot
1	0	Ft Rucker, AL	AH-64 flight training spt
14	3		

2. APPROACH

2.1 General.

A life cycle cost comparison of alternatives is conducted in this study as follows. The first step is to define the alternatives. Five alternatives, to include the status quo, and four shelter configurations for IFTE are considered in this study. These alternatives and configurations, described in Section 2.3, consist of the different options available for fielding IFTE. The second step in the approach, which will be explained in detail in Section 2.4, is to determine the quantity of ATE to be considered. Operating differences between EETF and IFTE could impact the number of systems required. The maintenance structure and the deployment of ATE could also impact the number of systems required. The third step is to derive the production and fielding schedules for the EETF and IFTE. This is necessary for two reasons. First, it is necessary to account for the time frame of availability of various hardware (IFTE, EOB) and TPS development in order to determine feasible schedules. Second, it is necessary to determine the quantity of each system being produced and fielded in a given year so that appropriate costs can be attributed to each item during each phase, and a funding profile can be determined. This is explained in Section 3.2. The life cycle costs, consisting of development, production, fielding, and sustainment, for each of the alternatives and configurations, are derived in the fourth step. These results are explained in detail and the life cycle costs of alternatives are compared in Section 4.1. All alternatives are compared over the same twenty year time frame (FY92 through FY11). Since the IFTE is not expected to be fielded for Apache until FY98, the EETF is treated as an interim system and associated costs are attributed to all IFTE alternatives. Finally, various sensitivity analyses, detailed in Section 4.3, are conducted to determine the sensitivity of results to various assumptions.

2.2 Assumptions.

Several assumptions, which impact on the application and derivation of costs for each alternative, are made for conducting this analysis. These assumptions are:

a. All costs expended or obligated before FY92 are assumed to be sunk. These costs include both EETF and ECP185R(2) development and procurement costs. Sunk costs also include all the fielding costs for the EETF except for the six units yet to be delivered.

b. Costs attributed to IFTE development, system test and evaluation, PM TMDE project management, and common engineering changes are not included in the IFTE costs. Since the IFTE will also be used to support other systems, these costs will be accrued regardless of whether IFTE is bought to support Apache. Therefore, these costs are not considered applicable to the support of Apache.

c. The ATE used to support Apache will be used at the AVIM level and will be dedicated solely to the support of Apache. See Section 4.3.4 for a sensitivity analysis of the results to the sharing of ATE assets with other systems.

d. With one exception, the current Apache support structure and deployment of tactical EETF units require a one-for-one replacement of EETF with IFTE. See Section 2.4.1 for further details to support this assumption.

e. Nine of the 14 non-tactical, floor-mounted EETF's will be replaced with dedicated IFTE assets. See Section 2.4.2 for further details on this assumption.

f. IFTE will be fielded, in support of Apache, beginning in FY98 and will be a gradual replacement. In other words, the EETF is assumed to be an interim system until replaced. The replacement with IFTE will not be all at once, but will take place over several years.

g. The IFTE EOB will be available in FY94.

h. The TPS/ICD development period is approximately two years.

i. The useful life of the EETF, with incorporation of the ECP185(R)2, is twenty years. The useful life for IFTE is also twenty years.

j. The EETF EOB is not compatible with the IFTE computer. In order to retain the EETF EOB for use with IFTE, either of two things are required. A separate computer will be required for the EETF EOB to interface with IFTE, such as retaining the upgraded Core-410 computer, or a major engineering and redesign effort will be required to reconfigure/integrate the EOB with the IFTE computer. The cost estimates presented in this report assume the first.

k. The IFTE currently does not have all the required APE capabilities. Therefore, some of the APE, currently used on the EETF, must be retained if Apache transitions to IFTE. Per reference 5, the APE items required are: the video monitor (with fiber-optics probe), the photometer, the pneumatics module and the 400 Hertz (Hz) power station. The retention of APE impacts on sustainment costs. Since sustainment costs attributed to individual items are unknown, it is assumed that 25 percent of the total of APE sustainment costs are appropriate.

2.3 Alternatives.

There are five alternatives considered in the analysis. These alternatives consist of the base case - maintaining the status quo, and four options for transitioning to IFTE. Alternatives considered are:

a. EETF with ECP185(R)2 - Retain the EETF and continue to upgrade the Core-410 computer control and display subsystems with ECP185(R)2 equipment. This is considered the baseline alternative.

b. IFTE with EETF EOB - Transition to IFTE, but retain the EETF EOB. In this alternative, the ATE located in the test van, would be replaced with the IFTE BSTS. This equipment would be located in either the current test van, an S-280 shelter or another suitable shelter. The current EETF EOB would be retained and, along with the APE, would be located in the same test van or a separate S-280 shelter.

c. IFTE with New EOB - Transition to IFTE and utilize a new EOB developed by the Navy. In this alternative, all the EETF ATE including the EOB would be replaced with the IFTE BSTS and a new IFTE EOB.

d. IFTE with Dual Work Station - Transition to IFTE, utilize the new EOB, and replace the single work station with a dual work station. Both work stations would share the same computer allowing two LRU's to be fault isolated simultaneously for improved Apache support. See Appendix B for an illustration of a previously developed concept of the dual work station version of IFTE.

e. IFTE with No EOB - Transition to an IFTE without the EOB capability. All TADS/PNVS LRU's normally fault isolated by the EOB would be sent directly to a Special Repair Activity (SRA) for fault isolation and repair.

There are four different shelter configurations considered for housing the IFTE BSTF. It is necessary to consider different configurations because of the limited space available in the S-280 shelter, the space requirements of ATE, and worker maneuverability. The necessary ATE, consisting of the IFTE BSTS, the EOB, and the APE, will not all fit in one S-280 shelter due to the limited space available. Moreover, due to the large size of some of the Apache LRU's, more space than what is available in an S-280 shelter is required for optimal crew maneuver and work activity. The current EETF test van has the required space for the IFTE BSTS, EOB, APE, and crew. Finally, all the TPS's and ICD's required for fault isolation of Apache LRU's, currently housed in one storage van, would require two S-280 shelters.

The configurations considered are listed in Table 3. As shown, the configuration option is indicated in column one. IFTE components, as identified for storage requirements, are listed in column two. Each set of components could be housed in either an expansible EETF van (a tractor trailer type vehicle expandable on both sides), or an S-280 shelter mounted on the bed of a 5-ton truck. The third and fourth columns indicate where the components would be housed for each of the optional configurations. The total number of vans or shelters needed for each configuration is also shown. The options range from putting all IFTE components of one BSTS into the two current EETF vans to putting them all in four S-280 shelters.

Table 3. IFTE CONFIGURATIONS

Config	Components	EETF Vans	S-280 Shelters
A	BSTS APE & EOB	1	
	TPSs/ICDs	1	
		2	
B	BSTS		1
	APE & EOB	1	
	TPSs/ICDs	1	
		2	1
C	BSTS		1
	APE & EOB		1
	TPSs/ICDs	1	
		1	2
D	BSTS		1
	APE & EOB		1
	TPSs/ICDs		2
			4

2.4 ATE Requirements.

2.4.1 Tactical ATE Requirements. There are several factors which are taken into account when determining the number of EETF's and IFTE's to be considered for each of the alternatives. The main factors are workload, ATE capacity and work schedule to perform the workload, and the current deployment of ATE to support Apache. In addition, there are three versions of the Apache; referred to as series A, B, and C; which have a differing number of LRU's requiring fault isolation by ATE. Therefore, the workload required is a function of the model of the Apache. Workload is also impacted by the number of aircraft supported, LRU failure rates, TPS run-times and throughput-times, the flying hour program, the productivity level of ATE crew members, and the number of LRU's being sent to the ATE facility for test with "No Evidence Of Failure" (NEOF). And finally, the capacity of the EETF has been expanded with the ECP185(R)2 upgrade which reduces the number of EETF's required to accomplish the workload.

Historically, the peacetime flying hour program has varied on a monthly basis from a low of four hours to a high of 19 hours per month per aircraft. Yearly averages, for the past few years, have run from 12.5 to 13.5 hours per month per aircraft. The Prime Item Development Specification states a peacetime requirement of 20 hours per month. The current Army standard as determined by the Deputy Chief of Staff for Operations (DCSOPS), DA, is 13.3 hours per month.

Figures 1 and 2 show the workload required in hours per month and the associated number of EETF's required to support that workload. The workload required is that to support 54 aircraft during peacetime operations and represents the total hours required per month if all the faulty LRU's are sent to the EETF for fault isolation. Figure 1 represents the workload required for a flying hour program of 13.3 hours per month per aircraft and Figure 2 represents the workload required for a flying hour program of 20 hours. The capacity of the EETF's to accomplish the work is shown for EETF's operating one shift per day, eight hours per shift and five days per week (Figure 1) and two shifts per day, nine hours per shift and five days per week (Figure 2). The workload is also broken out on both charts by type of LRU, TADS/PNVS, Hellfire, or Apache peculiar; and the type of aircraft being supported, A, B, or C. The productivity of the crew is assumed to be 85 percent and the NEOF rate to be 30 percent. Finally, the number of EETF's required to support the 54 aircraft is indicated on the right side of the charts.

In the past, not all failed LRU's have been sent to the EETF for fault isolation and, therefore, on the average, the EETF's have only been operating one shift per day. However, this is not due to lack of capability nor capacity, but rather to the unit commander's discretion. Often, due to lack of availability of spares, the LRU's are sent directly to an SRA for immediate repair.

Figures 1 and 2 also reflect the improvements expected in workload accomplishment due to the ECP185(R)2 upgrade to the EETF. The EETF TPS run time is reduced by an average of 47 percent with the ECP185(R)2 upgrade (reference 6). This translates to about a 12 percent reduction in throughput time.

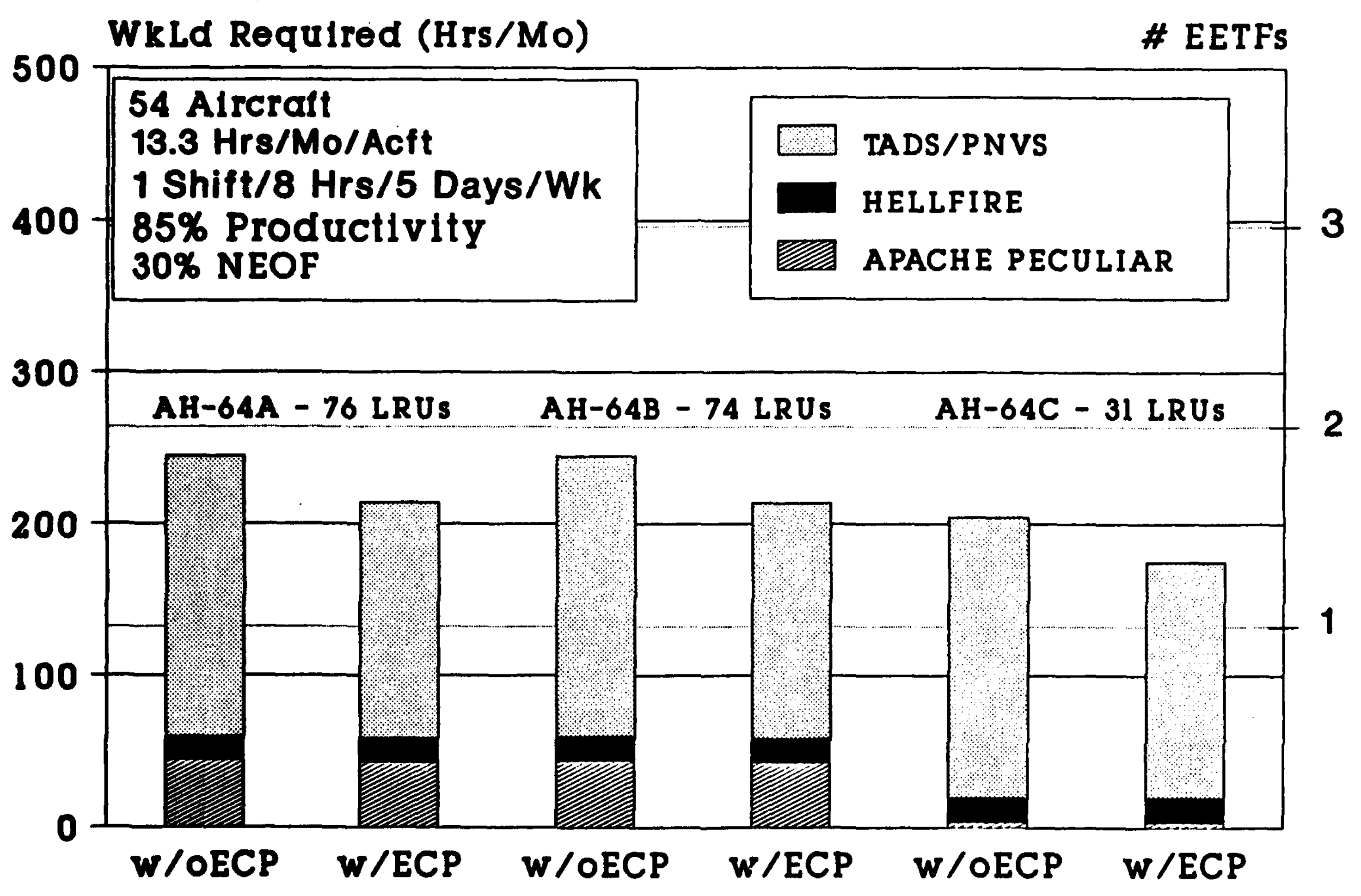

Figure 1. EETF Requirements vs. Workload
Average Peacetime Flying Hour Program

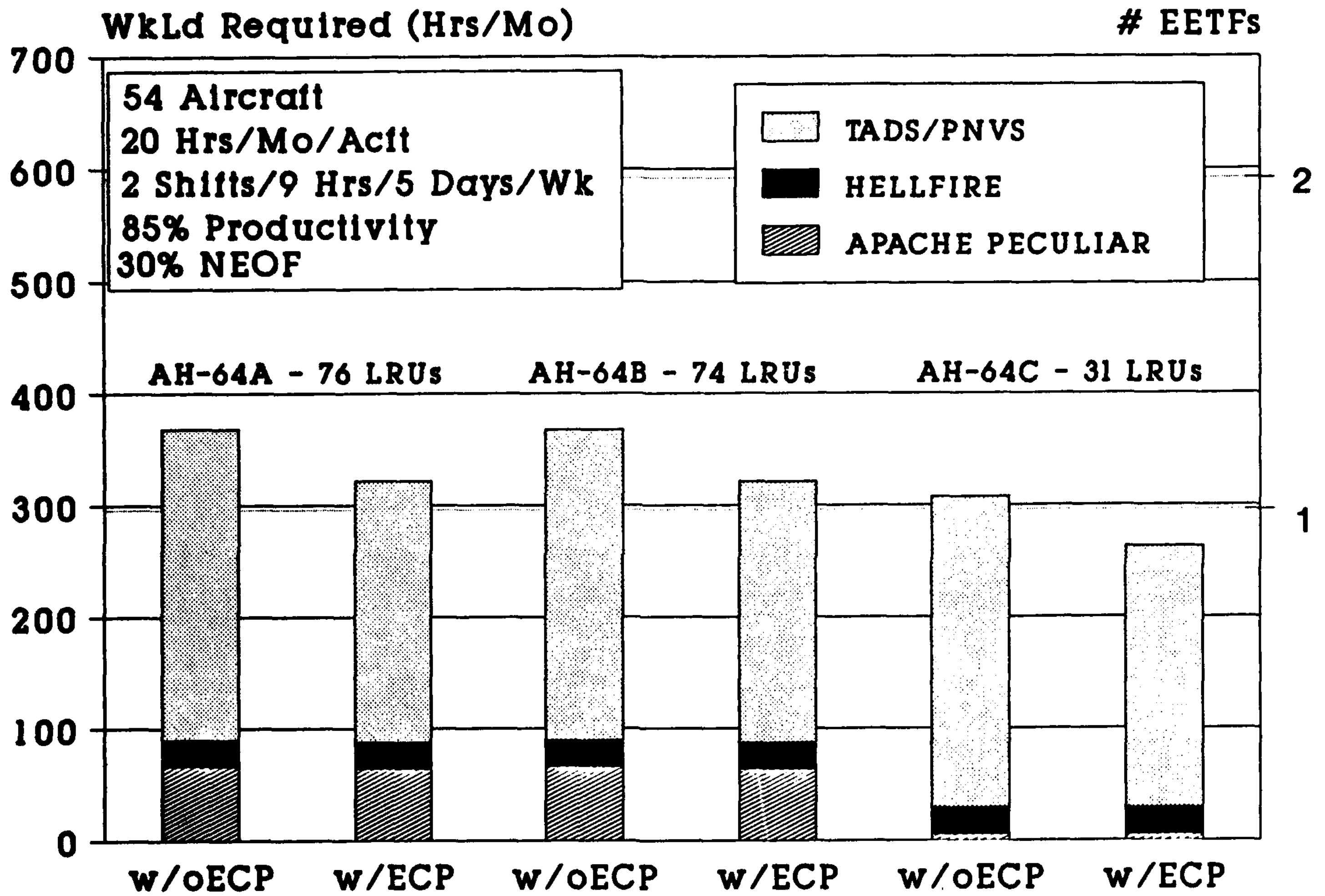

Figure 2. EETF Requirements vs. Workload
High Peacetime Flying Hour Program

As shown in Figure 1, two EETF's operating on a 1-8-5 schedule are required to support 54 aircraft. However, as shown in Figure 2, by going to two nine-hour shifts, the reductions in throughput time due to the ECP185 upgrade brings the number of EETF's required to accomplish even the greater workload (20 flying hours) down to approximately one when averaging across aircraft type.

One advantage of IFTE is reported to be reduced TPS run time. There are no data available on IFTE TPS run times. However, a TPS for the Multiple Launch Rocket System (MLRS) fire control system, which had previously run on the EQUATE, has been rewritten for the IFTE. Note, the MLRS originally had the EQUATE, not the EETF ECP upgrade. There is only a 25 percent reduction in the run time for this TPS when it is run on IFTE as compared to the EQUATE system. A direct comparison can not be made between EETF and IFTE TPS run times to determine if a lesser quantity of IFTE's will be required to support Apache. When compared to the run time reductions experienced with the ECP upgrade on the EETF, however, the evidence from the MLRS indicates that as many or more IFTE's as EETF's will be required to support Apache.

The deployment of tactical EETF's is as shown in Table 1. There is currently one EETF, capable of supporting 54 aircraft, allocated per Apache AVIM. When the units supported move, the EETF moves as well. It will be difficult for the ATE to support Apaches from another unit if these aircraft are not located in the same geographical area. Based on the above considerations, it is assumed that the current support structure, one per AVIM, will be appropriate for IFTE as well. In other words, the replacement of tactical EETF's with IFTE is assumed to be on a one-for-one basis.

Proposed changes to the force structure could also impact ATE requirements if the number of aircraft requiring ATE support are reduced or consolidated by geographical location. There are no data available which quantify these possible reductions, but the number of aircraft is not expected to be reduced from the present number of 807. Units are instead expected to be brought back from Europe and relocated at Continental United States (CONUS) installations. A sensitivity analysis of results to requirements is performed and is described in Section 4.3.2. If proposed force structure changes do eventually affect the number or deployment of Apache aircraft, then the impact on ATE would be the same for EETF and IFTE.

One of the tactical EETF's is currently on loan to Israel and one is used by the Ordnance Missile and Munitions Center and School (OMMCS) as a training facility. The one in Israel is scheduled for return in August 1992 and is planned to be used at the Mississippi Gulfport Aviation Classification and Repair Depot (AVCRAD). According to the PM Apache ATE, the one tactical EETF at OMMCS will not be replaced by IFTE. There is an IFTE facility already at OMMCS that is used for the same purpose for which the EETF is currently being used and would be able to absorb the additional training load from the Apache ATE crew members. Another IFTE may be installed, but it would be used as a common training base regardless of the Apache ATE decision.

For the reasons stated above, it is assumed that the 22 tactical EETF's will be replaced with 21 dedicated IFTE's.

2.4.2 Floor-Mounted ATE Requirements. There was much controversy voiced concerning the number of floor-mounted EETF's that needed to be replaced with IFTE's and whether or not these assets would still be dedicated to Apache. These EETF's are not assigned to AVIM's nor per number of aircraft, but to specific agencies or commercial contractors to perform specific functions to support the Apache program as shown in Table 2. The question is whether those specific functions will be required if Apache transitions to IFTE and whether those functions will still be dedicated or common among systems supported by IFTE. Therefore, it is difficult to determine the exact number of IFTE's required to replace the floor-mounted EETF's.

Based on a consensus of opinions from PM TMDE, PM Apache ATE, and AMSAA personnel, more than half of the floor-mounted EETF's will require replacement. It is agreed that the EETF's that are currently used in support of the Core-410 system will not need replacement. This is because these systems will no longer need supporting when the ECP185(R)2 upgrade is fully fielded. Therefore, it is assumed that the EETF's used in support of the Core-410, the three at General Electric and the one used by the Communication and Electronics Command (CECOM), will not be replaced. It is determined that the two EETF's at McDonnell Douglas will be replaced with one IFTE Commercial Equivalent Equipment (CEE) package and one Army TPS Support Environment (ATSE) work station. The ATSE work station will be used to develop TPS's and the one CEE will be used to test them on equipment like the full-up IFTE. Also, the two EETF's at Martin Marietta will be similarly replaced. An agreement could not be reached about the EETF currently located at Tobyhanna Army Depot (TOAD) and whether the depot organic support capability will still be required. For this analysis, it is assumed that this capability will not be needed and this EETF will not be replaced. Therefore, in total, it is determined that nine floor-mounted EETF's will be replaced with seven dedicated IFTE CEE's and two ATSE work stations.

Because of the differing opinions on the number of floor-mounted EETF's to be replaced with IFTE, a sensitivity analysis is conducted. This analysis is described in Section 4.3.5.

3. INPUT DATA

3.1 General.

This section of the report details the input data received from various sources. Cost categories, development, production, fielding and sustainment, and cost elements are explained in the sections below. The cost elements contained in each of the categories are defined in the guidance for Baseline Cost Estimates (BCE's) (see reference 7). Unless otherwise noted, all costs used in this analysis are displayed in constant FY91 dollars. Data were furnished primarily by PM Apache ATE, PM TMDE, CECOM, and OMMCS. Other agencies providing specific data were Tobyhanna Army Depot (TOAD) and the Aviation Systems Command (AVSCOM) ATE Center.

The PM Apache ATE provided EETF costs and quantities along with hardware descriptions as presented in their Decision Coordinating Paper for

the OQ-290(V)2 MSM, EETF (see reference 8). They provided current TPS/ICD costs and quantities along with descriptions of the TPS's. They provided the deployment distribution and use of tactical and floor-mounted EETF's. They provided the number of Apache helicopters currently in the field and delivery schedules for those yet to be fielded. Finally, the impact of the various Apache models on the number of TPS's was provided.

The PM TMDE provided IFTE costs and quantities as presented in their BCE for IFTE (reference 9), the appropriate costs and quantities for a new EOB as presented in a separate EOB BCE (reference 10) and estimates of the development cost for new TPS's and ICD's (reference 11). The IFTE BCE was updated in early June 1991 and had not yet been fully validated at the time of this evaluation.

CECOM provided the costs and schedules of the ECP185(R)2 and the impact on tactical and floor-mounted EETF's. They also provided input into a history of EETF ECPs. Finally, they provided cost estimates of the impact to incorporate organic maintenance of the EETF at depot levels as compared to contractor maintenance.

OMMCS provided the training requirements for EETF and IFTE and a proposed IFTE production and fielding schedule. They also provided data for estimating EETF and IFTE training costs.

TOAD provided an estimate of the costs of integrating the basic IFTE BSTF into the EETF vans. Costs include the engineering effort required for redesign and reconfiguration of ATE hardware and installation efforts required in order to remove the EETF ATE and install the new IFTE ATE.

The AVSCOM ATE Center provided input pertaining to the need to retain various individual components of the APE if Apache transitions to IFTE.

Based on a review of these inputs, AMSAA determined the costs associated with fielding the remaining six EETF's, incorporating the ECP185 and sustaining the 22 tactical and 14 floor-mounted EETF's. The appropriate costs for acquiring, fielding, and sustaining the various IFTE options are also determined. Special care is taken to assure that cost estimates are consistent among all alternatives. Specifically, missing cost elements are estimated to include the training costs associated with EETF and the sustainment costs for retaining both the APE and the current EOB. The methodology used to estimate these costs is described in Section 3.6.

3.2 Production and Delivery Schedules.

At publication, 665 Apache helicopters, out of 807 funded, have been fielded. Six of the tactical EETF's and one of the floor-mounted EETF's remain to be fielded. Only six of the ECP185 upgrades have been installed with the remaining kits to be installed in FY92 and FY93. The first fielding of IFTE BSTFs is in FY91 for the Hawk system. According to a schedule developed by OMMCS, fielding of IFTE's for the Apache and other aviation systems will begin in FY98. The new EOB will be available by FY94 and the TPS/ICD development period is estimated to be approximately two years. Based

on OMMCS input and the availability of the new EOB and new TPS's/ICD's, IFTE production to support Apache is assumed to begin in FY97. Assuming that delivery of assets to the Army can begin one year later, IFTE is assumed to begin fielding in FY98. Table 4 shows the production and fielding schedules of alternative ATE, both tactical and floor-mounted, by fiscal year, which are derived for use in the Life Cycle Cost (LCC) comparison. The costs for production and fielding which occurred prior to and including FY91, as shown in Table 4, are sunk costs.

Table 4. PRODUCTION AND FIELDING SCHEDULES.

Hardware/ Schedule	FY91 & Prior	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	Total
									Quantity & Schedule								
EETF																	
Tactical																	
Production	22																22
Fielding	16	2	4														22
Floor-Mounted																	
Production	14																14
Fielding	13		1														14
ECP185																	
Tactical																	
Production	22																22
Fielding	2	16	4														22
Floor-Mounted																	
Production	14																14
Fielding	4	10															14
IFTE BSTF																	
Tactical																	
Production							4	4	2	2	2	2	2	3			21
Fielding								4	4	2	2	2	2	2	3		21
Floor-Mounted																	
Production							1	1	1	1	1	1	1				7
Fielding								1	1	1	1	1	1	1			7
IFTE EOB																	
Tactical																	
Production							4	4	2	2	2	2	2	3			21
Fielding								4	4	2	2	2	2	2	3		21
Floor-Mounted																	
Production							1			1			1				3
Fielding								1			1			1			3

3.3 Development Costs.

Table 5 shows the total development costs provided by PM Apache and PM TMDE as required for the alternative options (references 11 and 12).

Table 5. DEVELOPMENT COSTS.

Item	Cost ($M)
EETF	
Hardware	0.0
ECP185(R)2	0.0
TPS's/ICD's	0.0
IFTE	
Hardware	0.0
TPS's/ICD's	
w/Old EOB	18.3
w/New EOB	22.5
Dual Work station	20.0

As shown, the EETF hardware, ECP185(R)2, and TPS/ICD development costs are considered sunk. Therefore, there are no additional development costs yet to be expended for the EETF. The IFTE hardware development costs are required regardless of how Apache is supported and therefore are not attributable to Apache. There are two separate development costs estimated for the modification of TPS's/ICD's. The Electro-Optic (EO) TPS's/ICD's will not require modification if the old EOB is retained for use with IFTE whereas modifications will be needed for all TPS's/ICD's if a new EOB is used. There are 75 separate sets of TPS's/ICD's of which 14 are EO associated. (Fewer TPS's/ICD's are required for aircraft versions B (73) and C (29), however, it is assumed that the IFTE will need to be capable of testing all versions of the Apache.) The cost of individual TPS/ICD modifications are reflected in the development costs shown. The IFTE BSTF dual work station concept is an IFTE configuration for which, to date, only a prototype has been built. The following approximate costs would be incurred to complete development of the dual work station configuration:

	Costs ($M)
Update Full Scale Development (FSD) configuration package to production demonstrator	2.0
Convert S280 shelter to 410 configuration package	2.0
Software modification	2.0
Build one unit	8 - 10.0
Test, verification, etc.	5.0
	19 - 21.0

3.4 Production Costs.

The production costs estimated for each system and used in the LCC comparison are displayed in Table 6. The costs are shown by cost element and by hardware/software item. These costs were provided in references 8 through 11 and 13.

Table 6. PRODUCTION COSTS.

	Costs ($K/System)				
		IFTE			
Cost Element	EETF with ECP185	BSTS	TPS's & ICD's	New EOB	Dual Station
Non-Recurring	0.0	0.0	0.0	0.0	0.0
Recurring					
ATE/TPS's/ICD's	0.0	1343.0-2244.8	1047.9-1490.1	2178.6	300.0
Shelter		51.2			
Truck		72.5			
Engineering Changes	0.0	6.5	0.0	0.0	0.0
Data	0.0	51.2	0.0	28.8	0.0
Training Services & Equipment	0.0	0.0	0.0	3.2	0.0
Initial Spares	0.0	323.9	0.0	217.9	0.0
Other Production	0.0	56.8	0.0	106.9	0.0
Total Production	0.0	1781.5-3171.1	1047.9-1490.1	2535.4	300.0

The production costs for the EETF and ECP185 hardware are considered sunk costs. The recurring production costs for the IFTE BSTS reflect a learning curve, which is applied and broken out by fiscal year in the BCE costs supplied by the PM TMDE. The costs shown account for total IFTE production to support several systems as reflected in the BCE. Recurring production costs for the IFTE BSTS start in FY92 at $2.245M and gradually decrease to $1.343M per system. The production costs for each S-280 shelter and each 5-ton truck are shown separately from the IFTE BSTS. The recurring production costs for TPS's/ICD's are again dependent on the number of new TPS's/ICD's and the complexity of TPS's. Production costs vary from $1.048M for the current EOB with IFTE to $1.490M for the new EOB. The range displayed considers each of these EOB options. A cost of $6.5K per system would be incurred for the engineering changes required, if the BSTS were integrated and installed into the EETF vans (configurations A-C in Table 3). Note, that only three of the nine floor-mounted EETF's currently have EOB's and, therefore, would have production costs incurred if an IFTE EOB were added.

3.5 Fielding Costs.

Table 7 shows the fielding costs estimated for each system and used in the LCC comparison. The costs were provided in references 4 and 8 through 10.

Table 7. FIELDING COSTS.

	Costs ($K/System)				
			IFTE		
Cost Element	EETF	ECP185 Upgrade	BSTS	New EOB	Dual Station
Training Services & Equipment	0.0	0.0	2.4	1.3	0.0
Transportation	32.8	2.5	12.9	0.2	0.0
Initial Spares & Repair Parts	130.1	0.0	89.7	105.9	0.0
Other(Installation)	2.1	12.3	0.0-95.8	0.0	0.0
Total Fielding	165.0	14.8	105.0-200.8	107.4	0.0

Sixteen of the 22 tactical EETF's have already been fielded. The remaining six are to be fielded in FY92 and FY93. The fielding costs shown per system for the EETF hardware are for those six remaining systems. Because only six of the ECP185(R)2 upgrades for the EETF's have been fielded, 30 upgrades will incur fielding costs. These costs are included in the LCC

comparison. The BSTS column total varies from $105K to $200.8K depending on the configuration being considered. The unit cost for installing each BSTS in the EETF van is estimated to be $95.8K (reference 14). This cost only applies to configuration A (see Table 3). In all other configurations considered, the BSTS is left mounted in the S-280 shelter which is the basic configuration for IFTE. Keeping the storage van to house the TPS's/ICD's will incur no additional installation costs. Fielding costs for TPS's/ICD's are considered negligible and therefore are not included. Note, again, that only three of the nine floor-mounted EETF's to be replaced have EOB's for which fielding costs will be incurred.

3.6 Sustainment Costs.

Sustainment costs are determined based on the costs per system per year, the number of systems supported in each year and the number of years of system sustainment. Unit sustainment costs are determined based on BCE inputs of total sustainment costs and the number of associated system years represented. A system year is defined to be the number of systems supported per year. Sunk costs are excluded in determining unit sustainment costs. Total sustainment costs are then estimated based on the total number of each of the systems supported each year times the unit cost per system year summed over the total number of years of the time-frame of analysis (FY92 through FY2011).

Recurring training costs and factors for the EETF crew were provided by OMMCS. Although different costs and factors were provided for the IFTE by PM-TMDE, the same methodology and factors as for EETF are used where appropriate to estimate IFTE training costs. There are normally two elements of recurring training costs (Replacement Training Services and Equipment and Military Pay and Allowances). Since OMMCS rolled their cost estimate into one number and did not breakout the above elements, our estimates are generated for one specific element - replacement training. The following formula is used to estimate the training costs per system per year:

Cost = Student costs per week x
No. of crew members per system x
Crew member turnover rate x
No. of weeks of advanced individual training +
Proponency management

where:

Student costs per week = $1748 (reference 29). This cost includes direct costs for instruction, overhead, equipment depreciation, student pay and allowances, per diem, and travel, and indirect costs for base support, medical support, and family housing.

No. of crew members per system = 6 for EETF, 4 for IFTE with new EOB, 6 for IFTE with old EOB, 6 for IFTE with dual work station, and 4 for IFTE with no EOB (reference 17).

Crew member turnover rate = 0.218 (reference 15).

No. of weeks training = 44 weeks total for EETF MOS 39BX (including 30 weeks basic training and 14 weeks EOB training), and 30 weeks total for IFTE MOS 35Y (including 27 weeks basic training and 3 weeks EOB training) (see references 16 and 29).

Proponency management = $50,000. This is a yearly cost for the EETF for as long as it is being supported. This cost accounts for one man-year of effort for MOS proponency management (reference 29).

IFTE will require the retention of APE from the EETF in order to provide all the capabilities necessary for testing of Apache LRU's. The retention of the current EOB is also considered as an option for fielding IFTE to support Apache. Because these items are not currently a part of the IFTE system, estimates of associated sustainment costs had to be derived. EETF sustainment costs are allocated to individual major components, based on the same ratio as hardware production costs, as the basis for estimating the APE and EOB sustainment costs for IFTE. The total EETF sustainment costs are divided among the four major components, Core-410, APE, EOB, and TPS's/ICD's hardware. The percentage production costs of each of these components to the total production cost is calculated. The following percentages are derived:

Component	Hardware Production Costs	Percentage
Core-410 w/ECP	1.150	23
APE	0.600	12
EOB	1.600	33
TPS's/ICD's	1.552	32
Total	4.902	100

* Costs are shown in Constant FY88 $M.

It was reported by PM-Apache that support of the vans and air conditioner are negligible and do not contribute much to the sustainment costs (therefore, hardware costs are not included above). For lack of better data, the above percentages are applied to the sustainment costs per system year for EETF to estimate both the APE and EOB sustainment costs for IFTE. The APE sustainment costs are reduced even further to account for retaining only a portion of the total APE. It is assumed that 25 percent of the total of APE sustainment costs are applicable to IFTE.

Table 8 shows the sustainment costs, per system year, used in the LCC comparison. These costs are based on inputs provided in references 8 through 10 and 13. Sustainment costs shown are representative of the individual components of the ATE. The three total costs at the bottom of the table are the total sustainment costs per system per year for each of the IFTE options. The total cost includes the total for each of the BSTS, APE, and EOB being considered. For example, the $348.4K is the total for support of the BSTS, APE, and Old EOB. The New EOB total, $208.1K, is the total for the BSTS, APE, and New EOB. The dual station total, $280.6K, consists of the

BSTS, APE, New EOB, and dual station (the dual station will require an EOB).

Table 8. SUSTAINMENT COSTS.

	Costs ($K per system per year)					
		IFTE				
Cost Element	EETF	BSTS	APE	Old EOB	New EOB	Dual Station
Replenishment Spares & Repair Parts	16.9	6.1	0.5	5.6	18.5	0.1
Petroleum, Oil & Lubricants	0.0	0.0	0.0	0.0	0.0	0.0
Depot Maintenance	117.8	9.0	3.1	49.1	0.3	0.2
Field Maint - Civ	0.0	0.2	0.0	0.0	0.3	0.0
Transportation	1.4	0.0	0.0	1.3	0.0	0.0
Replacement Training	101.5	41.5	0.0	32.3	4.8	20.8
Crew Pay & Allowances	149.1	102.5	0.0	49.2	0.2	51.3
System Project Management	3.6	3.6	0.0	0.0	0.0	0.0
Modifications/Kits	73.7	6.9	1.1	12.3	5.3	0.1
Other (TPS Support)	62.4	1.6	1.9	20.6	0.7	0.0
Total Sustainment	526.4	171.4	6.6	170.4	30.1	72.5
				348.4	208.1	280.6

For the IFTE alternative where the current EETF EOB is considered for retention, it is assumed that the Core-410 computer would also be retained in order to run the EOB since the EOB is not compatible with the IFTE computer. Therefore, the sustainment costs for this option are weighted to account for the EO workload to be run with the Core-410 computer and the remaining workload to be run with the IFTE computer. Workload data for the various types of LRU's are shown on Figure 1. As shown, workload is also dependent on the series of aircraft supported. Therefore, total sustainment costs (SUS-CST) for this alternative (IFTE w/EETF EOB) are computed using the following weighting scheme:

$$\text{SUS-CST} = (\text{APE-csts} + \text{EOB-csts} + \text{WGTeo} \times \text{Core-csts} + \text{WGTneo} \times \text{BSTS-csts}) \times \text{NO-IFTE}$$

where,

APE-csts = APE sustainment costs per system year,

EOB-csts = EOB sustainment costs per system year,

WGTeo = Weighting factor representing the percentage of workload that is EO related,

Core-csts = Core-410 sustainment costs per system year,

WGTneo = Weighting factor representing the percentage of workload that is non-EO related.

BSTS-csts = BSTS sustainment costs per system year,

NO-IFTE = The number of IFTE being sustained in each fiscal year.

The above weighting factors are determined based on the workload in man-hours per month to support 54 aircraft, the number of series A, B, and C aircraft supported and the time period for comparison. Two different weighting factors are determined in order to account for the EO workload vs. the non-EO workload. These factors change over the time-frame for analysis to reflect the upgrade of series A aircraft to series B and C. The weighting factors are determined as follows:

	Workload (man-hours per month)					
LRU's	A		B		C	
EO	236	(73%)	234	(73%)	234	(89%)
Other	88	(27%)	87	(27%)	29	(11%)

	Quantity of Aircraft		
Time Period	A	B	C
FY92-FY01	693	0	0
FY02 - FY11	0	580	227

The weighting factors for the first ten years are:

WGTeo = 73 percent
WGTneo = 27 percent

The weighting factors for the last ten years are:

WGTeo = (580 x 73% + 227 x 89%) / 807 = 78 percent
WGTneo =(580 x 27% + 227 x 11%) / 807 = 22 percent.

For the IFTE alternative which eliminates the EOB and sends the EO LRU's directly to the SRA's, it is assumed that only a portion of the sustainment costs are appropriate. In other words, the workload is considerably reduced thereby reducing the sustainment costs as well. However, the only portion of sustainment costs that would be reduced would be the first five and last two cost elements shown in Table 8. The sustainment costs for this option are also weighted to account for the EO workload not being tested by the IFTE. Therefore, total sustainment costs for this alternative (IFTE w/o EOB) are computed using the following weighting scheme:

SUS-CST = [APE-csts-678 + BSTS-csts-678 + (APE-csts-rem + BSTS-csts-rem) x WGTneo] x No-IFTE

where,

APE-csts-678 = APE sustainment cost elements six, seven and eight,

BSTS-csts-678 = BSTS sustainment cost elements six, seven and eight,

APE-csts-rem = remaining APE sustainment cost elements,

BSTS-csts-rem = remaining BSTS sustainment cost elements.

Four out of the nine floor-mounted EETF's being replaced by IFTE will be furnished to contractors. These are replaced with two Commercial Equivalent Equipments (CEE's) and two ATSE work stations. It is assumed that sustainment costs will not be applicable for these floor-mounted IFTE replacements in the LCC comparison. Sustainment costs will only apply to the five floor-mounted IFTE BSTSs that belong to the Army. Only one of these will have an EOB for which sustainment costs will be accrued. Crews of these remaining five are Apache repairmen. Therefore, both the training and pay and allowances costs for these repairmen are Apache costs and are not attributable to either EETF or IFTE.

3.7 Army TPS Support Environment (ATSE) Work Stations.

As mentioned earlier, the two floor-mounted EETF's at McDonnell Douglas and the two at Martin Marietta will be replaced with two IFTE CEE's and two ATSE work stations. The production, fielding, and sustainment costs for the CEE's are assumed to be equivalent to the costs for the BSTS (the production costs shown less the shelters and trucks are applicable). Rough estimates of the appropriate costs for the ATSE work stations are as shown below. These estimates were provided by PM-TMDE (reference 18). It is assumed that a multi-user work station with three client stations will be provided to each of the contractors. The software required to run the ATSE stations is assumed to be included in the cost of the hardware.

Production cost = $105.0K for single client station

$10.0K for added client station

$125.0K assuming three client stations

Fielding cost = insignificant

Sustainment cost = $0.2K per system year.

3.8 Additional Special Repair Activity (SRA) Costs.

The fifth alternative is to eliminate the EOB. If the EOB were eliminated, all TADS/PNVS LRU's would be sent directly to an SRA for testing/repair. This would do away with the need for all of the electro-optic LRU's to be tested at the AVIM, thus reducing the workload considerably. At the

same time, additional SRA costs would be accrued to accomplish the additional repairs. There would also be an increase in spares and repair parts in the pipeline and transportation costs for transporting the items to the SRA and back.

The current SRA contract supports the workload of an approximate fleet size of 650 aircraft at an annual cost of approximately $21.4 million. The number of EO LRU's supported in FY90 by the SRA's was 729 and the additional workload, if the EOB were eliminated, would be the 258 EO LRU's sent to AVIM last year. Therefore, the annual cost increase to support the additional workload at the SRA for the current aircraft fleet (SRA-CST) is estimated as follows:

$$\text{SRA-CST} = (T + P + C - A) \times (\text{LRUa} / \text{LRUc})$$

where:

T = Transportation costs obtained from AMSAA TADS/PNVS study (reference 19) = 1.475 M

P = Pipeline costs, obtained from AMSAA TADS/PNVS study = .35 M

C = Contract costs, obtained from AMSAA TADS/PNVS study = 21.4 M

A = AVIM costs eliminated, estimated by:
(AVIM labor rate / SRA labor rate) (SRA contract cost), or,
(39.00 / 142.00) (21.4 M) = 5.9 M

LRUa = additional LRU's for the SRA = 258 (reference 20)

LRUc = number of LRU's currently supported by the contract = 650 (reference 20)

This yearly increase in SRA support cost is then weighted by the average number of aircraft to be supported in years one through ten (725) and years eleven through twenty (807). Finally, this estimate is divided by the number of tactical EETF's (22) available to determine an average yearly increase in SRA costs per system. The following formula is used to estimate this weighted average (SRA-CST/SYS):

$$\text{SRA-CST/SYS} = [(\text{SRA-CST})(.5)(725 / 650) + (\text{SRA-CST})(.5)(807 / 650)] / 22 = \$329K$$

This cost, $329K, is used in the LCC comparison to consider the case of the IFTE being fielded without an EOB. For each year, this cost is multiplied by the number of IFTE's being sustained and the total is added to the IFTE costs to estimate the SRA maintenance cost. This estimate can be added to the yearly sustainment costs displayed in Table 8 for the IFTE BSTS and IFTE APE to calculate the costs of sustaining the IFTE with SRA support instead of an EOB. Therefore, this cost is estimated to be:

$167K + $34K + $329K = $530K per system year.

4. RESULTS

The results of the LCC comparison and sensitivity analyses of these results to assumptions are summarized in the sections below.

4.1 Life Cycle Cost Comparison.

Tables 9 and 10 summarize the results of the LCC comparison by major cost category. Table 9 presents the results for installing the IFTE BSTF in the EETF vans whereas Table 10 presents a comparison of the various configurations considered for housing the IFTE for Apache. The costs shown are based on the aforementioned data and assumptions. LCC are representative of the costs accrued for each alternative over a time period of 20 years, FY92 through FY2011. Therefore, the costs shown are cumulative totals of the costs for FYs 92 through 11.

Table 9. LIFE CYCLE COST COMPARISON.

	Costs (FY91 Constant $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	83.5	155.0	163.4	83.5
Fielding	1.6	4.5	7.1	7.1	4.5
Sustainment	231.3	219.0	157.4	174.1	146.9
SRA Costs					81.7
Total	232.9	325.3	342.0	387.1	334.9
Relative Cost	1.00	1.40	1.47	1.66	1.44

Table 10. LIFE CYCLE COST COMPARISON - CONFIGURATIONS.

		Costs (FY91 Constant $M)				
Costs	Confs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development		0.0	18.3	22.5	42.5	18.3
Production	A	0.0	83.5	155.0	163.4	83.5
	B	0.0	84.0	155.4	163.8	84.0
	C	0.0	86.6	158.0	166.4	86.6
	D	0.0	91.8	163.2	171.6	91.8
Fielding		1.6	4.5	7.1	7.1	4.5
Sustainment		231.3	219.0	157.4	174.1	146.9
SRA Costs						81.7
Total	A	232.9	325.3	342.0	387.1	334.9
	B	0.0	325.8	342.4	387.5	335.4
	C	0.0	328.4	345.0	390.1	338.0
	D	0.0	333.6	350.2	395.3	343.2

The columns containing the results of the LCC comparison refer to the five alternatives: EETF with the ECP185(R)2 upgrade; IFTE with the current EETF EOB; IFTE with the new Navy EOB; IFTE with the new EOB and a dual work station; and the IFTE without an EOB. For a more detailed description of the alternatives, refer to Section 2.3. The cost of the EETF with the current EOB, shown in Table 9, is divided into the costs of each of the other alternatives to determine their costs relative to the least cost alternative. The A - D options referred to in Table 10 in the production cost category refer to the different IFTE configurations detailed in Table 3.

As shown in Table 9, the least costly of all the alternatives is the base case, retaining the current EETF with the ECP185(R)2 upgrade. There is an approximate $92 million difference between this alternative and the next least costly which is IFTE with the current EOB. In other words, the least cost IFTE alternative costs approximately 40 percent more than continuing with EETF. Therefore, continuing to support the Apache with the EETF is the least cost alternative by a significant margin.

As shown in Table 10, if the Apache does transition over to IFTE, then configuration A, retaining the two EETF vans is the least costly configuration. One van will contain the BSTF, the other will be used to store

the TPS's/ICD's. There is an approximate $8 million difference between this configuration and the highest cost one which is to use four S-280 shelters. While this cost differential is not significant, it would appear to be more beneficial to use the current EETF vans. The vans will allow more space for the ATE and more space for the workers to maneuver the Apache LRU's for testing. This also allows for the fewest number of vehicles which enhances mobility and requires no dedicated trucks. See Section 5 for more details on the benefits, advantages and disadvantages of EETF vs IFTE and the various configuration options available to IFTE.

4.2 Funding Profile.

Figure 3 shows the cumulative LCC for each year in the LCC comparison. These costs are representative of the total costs displayed in Table 9. As shown, the ranking of each alternative in the LCC comparison is consistent throughout the entire life cycle period. The four IFTE alternatives appear to be converging on the EETF alternative in the out years, but at such a slow pace that IFTE will never be competitive with EETF during system life times. The slopes of the lines representing the alternatives with the old EOB and no EOB are steeper than the other alternatives. This is because the old EOB requires retention of the Core-410 computer. The Core-410 computer has a higher sustainment cost than the new EOB. Significant additional SRA costs are incurred over the remainder of the sustainment period for the no EOB alternative. Because there are no up front procurement costs for the EOB's, the old EOB and no EOB alternatives start out closer to EETF than the other two IFTE alternatives.

4.3 Sensitivity Analyses.

There were eight sensitivity analyses performed to determine if the ranking of alternatives in the LCC comparison is sensitive to any of the assumptions in the analysis. Some of these relate directly to the concerns voiced by USATMDEA and OMMCS and are discussed below. The following variables are considered in these sensitivity analyses and are explained in detail in the succeeding sections:

Production and fielding of IFTE,

Apache ATE quantity requirements,

Life cycle period and time-frame for analysis,

Shared vs. dedicated ATE support of Apache,

Replacement of floor mounted EETF's,

Retention of APE,

Residual value of IFTE, and

Inflation and discounting.

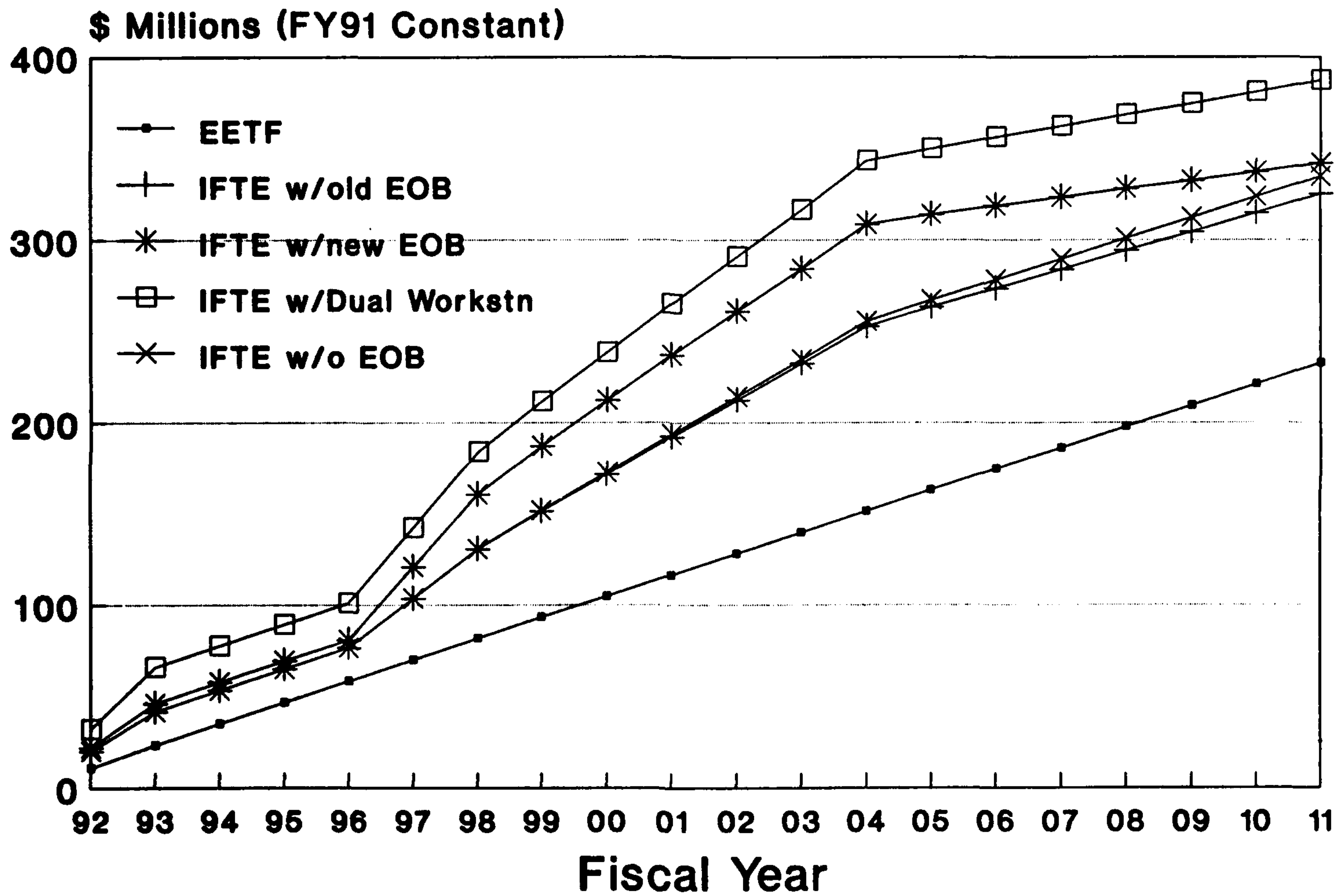

Figure 3. Funding Profile

Since the configuration of IFTE in either the current EETF vans or in S-280 shelters made little difference in the LCC comparison, the following sensitivities compare the alternatives based on retaining the current vans only. Two exceptions are the sensitivity analyses to residual value and to wartime requirements in which cases configurations B and D provide the least cost IFTE options respectively.

4.3.1 Earlier and More Rapid Deployment. This analysis is performed to determine the sensitivity of the cost results to assumptions regarding the production and fielding schedules for IFTE. This analysis addresses the least cost possible fielding alternative for IFTE. In the LCC comparison, EETF's are sustained for all of the IFTE alternatives until the IFTE systems are fielded to replace them. This occurs about halfway through the time-frame for analysis. A one year delay time is assumed between production and fielding of IFTE's in the LCC comparison. In this sensitivity analysis, it is assumed that all of the IFTE' are procured and fielded in FY92. Therefore, there are no penalties to IFTE from maintaining the EETF as an interim system until IFTE replaces it. Because IFTE is fielded at the beginning of the life cycle period, there are no EETF sustainment costs included in the IFTE estimates. IFTE is the only system being sustained in the IFTE alternatives. The results of this sensitivity analysis are displayed in Table 11.

Table 11. SENSITIVITY TO IMMEDIATE FIELDING.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	90.3	161.7	170.1	90.3
Fielding	1.6	2.9	5.5	5.5	2.9
Sustainment	233.4	205.4	93.0	123.5	73.9
SRA Costs					152.3
Total	235.0	316.9	282.7	341.6	337.7

As shown, the least cost alternative, as in the LCC comparison, is to retain the current EETF with the ECP185(R)2 upgrade. The least cost IFTE alternative is the IFTE with new EOB. There is an approximate $48 million difference between the two least cost alternatives. This difference

translates to a 20 percent increase in costs over EETF which is significant. The difference in costs between this IFTE option in this sensitivity analysis ($282.7M) and the same IFTE option in the base case ($342.0M - see Table 9) is approximately $59M which essentially defines the penalty to IFTE for late procurement and fielding.

4.3.2 Tactical ATE Requirements. If Apache units are brought back from Europe and/or if the planned total size of the Apache fleet is decreased for any reason, unit resources may be redistributed and there may be a lower requirement for ATE. This sensitivity analysis examines the cost impact of requiring fewer ATE. Holding all other variables constant, Table 12 shows the total LCC for requiring only 16 tactical ATE systems as opposed to the 22 reflected in the current requirements for EETF and in the LCC comparison. The requirements for both EETF and IFTE are decreased to 16 in this analysis. Requirements for floor mounted ATE are not affected by tactical requirements and are left unchanged in this analysis.

Table 12. SENSITIVITY TO TACTICAL ATE REQUIREMENTS.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	68.8	125.4	132.3	68.8
Fielding	1.6	4.0	6.1	6.1	4.0
Sustainment	177.6	170.9	119.1	133.0	110.2
SRA Costs					66.4
Total	179.2	262.0	273.1	313.9	267.7

As shown, the least cost alternative, as in the LCC comparison, is to retain the current EETF with the ECP185(R)2 upgrade. The next lower cost alternative is the IFTE which retains the current EOB. There is an approximate $83 million difference between the two least-cost alternatives. This difference translates to a 46 percent increase in costs over continuing with EETF. This difference is significant.

Some agencies are of the opinion that ATE should be bought to meet the workload requirements for a wartime operating tempo (see section 6.1, issues #1 and #2 for discussion of concerns relating to this subject).

Indeed, during a wartime tempo, the workload required for the maintenance of the Apache fleet increases considerably. The following sensitivity analysis examines the cost impact of buying ATE to meet wartime requirements.

According to the Prime Item Development Specification for the Apache, the wartime requirement which the Apache is designed to meet is a flying hour program of 113 hours per month per aircraft. Based on the current failure rates of LRU's, the amount of time required to test each LRU and the current deployment of EETF's and non-divisional AVIM's to support the Apache units, the number of EETF's (or IFTE's) required to accomplish the workload for a flying hour program of 113 hours is 55. It has been asked if the 113 hours per month is too high. Based on a Ft. Leavenworth study currently on-going, the wartime flying hour program during high intensity conflicts could range any where from 78 hours per month per aircraft to 173, depending on the scenario and location of war. For reference, the number of ATE systems required to support the fleet for an operating tempo of only 60 hours per aircraft is 34. Both of these numbers are based on around the clock operation of the ATE facility.

Figure 4 shows the total LCC as a function of the total number of tactical systems required to support Apache when all other variables are held constant. For reference points, vertical lines are used to specifically indicate the costs for the peacetime requirement quantity (21 systems) and for the wartime requirement quantities to meet flying hour programs of 60 hours and 113 hours per month per aircraft (34 and 55 respectively). The costs shown for quantities of the EETF greater than the current quantity of 21 (not counting the one at OMMCS) reflect buying additional EETF's at an average unit production cost of $9.5M. The costs shown for any quantities above the original 21 for the IFTE alternatives reflect buying new vans (for installing the BSTF) at an average unit cost of $.635M. Costs also reflect beginning production in FY93 for both EETF and IFTE in order to meet the higher requirement quantities. Again, requirements for floor-mounted ATE are not affected by tactical requirements and, therefore, associated costs are left unchanged in this analysis.

As expected, this analysis shows that the IFTE becomes more competitive with the EETF as the need for larger buy quantities increases. Moreover, two of the IFTE alternatives break-even with the EETF at quantities of approximately 32 (IFTE without EOB) and 41 (IFTE with new EOB). At the requirement quantity of 55 systems, both of these same alternatives cost significantly less than EETF and the differences between EETF and the other three alternatives are insignificant. Consequently, if Army policy were ever changed to buy ATE to wartime requirements, the preferred system would be the IFTE. At the other end of the spectrum, if the 22 EETF's could be replaced with fewer IFTE's, the break-even point is approximately 14. This is unlikely since workload accomplishment capabilities of the two systems appear to be equivalent.

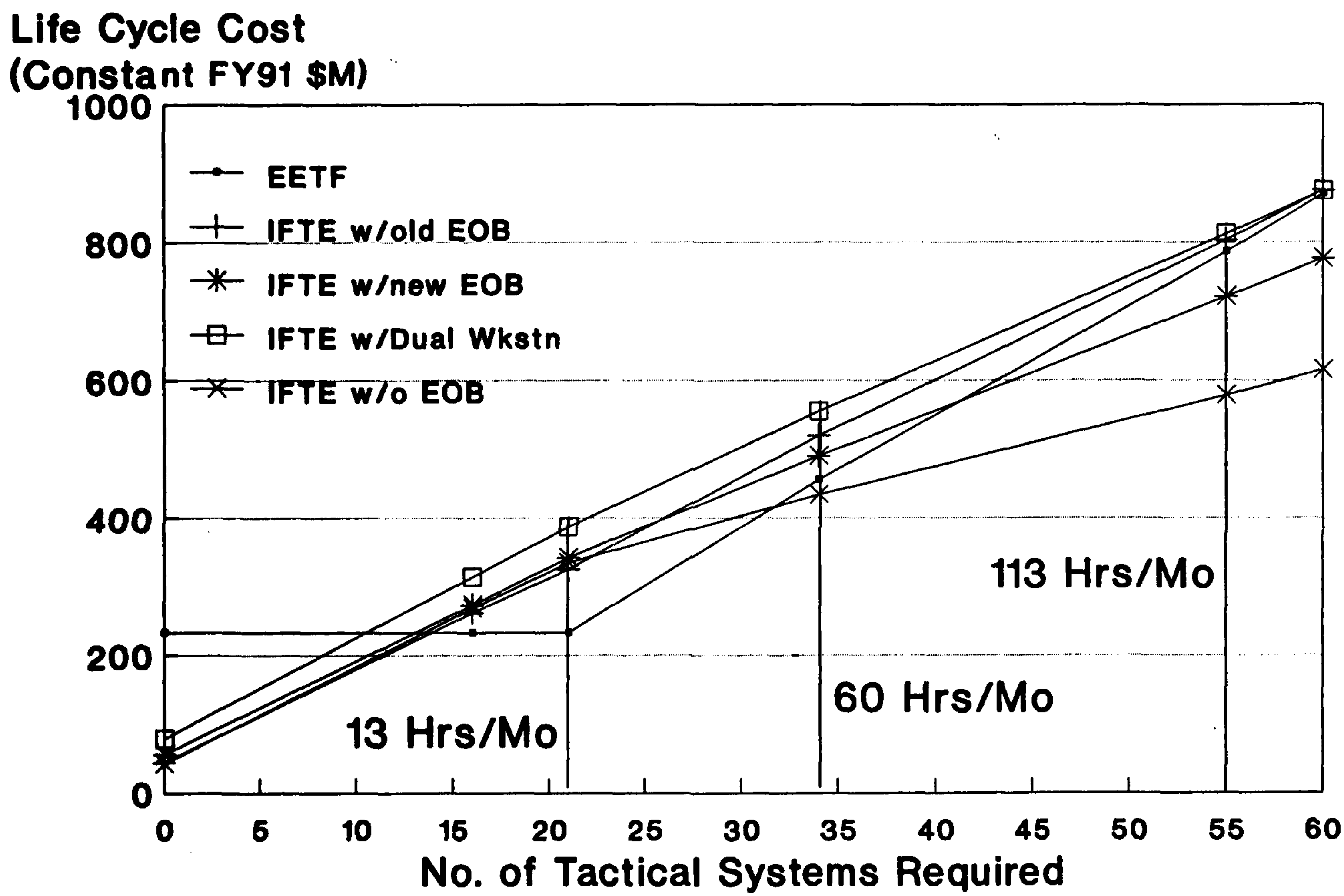

Figure 4. Sensitivity - Life Cycle Cost vs. Number of Systems Required

• IFTE BSTF installed in EETF vans

4.3.3 Life Cycle Period. In the base case analysis, it is assumed that both IFTE and the upgraded EETF have useful lives of at least 20 years. It is also assumed that Apache no longer has a need for ATE after 2011. Therefore, the appropriate time-frame for analysis is established to be FY92 through FY2011. In order to determine if the ranking of the alternatives is sensitive to the length of the useful life of ATE and therefore the life cycle period and time-frame for analysis, ten, fifteen, and twenty-five year life cycle periods are considered in this analysis. The fifteen, twenty, and twenty-five year life cycle periods and their cumulative LCC's are displayed in Figure 5 for each alternative. Tables 13, 14, and 15 show separate results for the ten year, fifteen year, and twenty five year life cycle periods, respectively. Table 13 also reflects immediate fielding since the current production and fielding schedules for IFTE are not completed by FY2001 (end of first ten years).

Table 13. SENSITIVITY TO TEN YEAR LIFE CYCLE PERIOD.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	90.3	161.7	170.1	90.3
Fielding	1.6	2.9	5.5	5.5	2.9
Sustainment	117.1	102.2	46.5	61.8	37.0
SRA Costs					76.1
Total	118.7	213.7	236.2	279.9	224.6

Table 14. SENSITIVITY TO FIFTEEN YEAR LIFE CYCLE PERIOD.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	83.5	155.0	163.4	83.5
Fielding	1.6	4.5	7.1	7.1	4.5
Sustainment	173.1	167.4	134.2	143.2	128.5
SRA Costs					43.6
Total	174.7	273.7	318.8	356.2	278.4

Table 15. SENSITIVITY TO TWENTY-FIVE YEAR LIFE CYCLE PERIOD.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	83.5	155.0	163.4	83.5
Fielding	1.6	4.5	7.1	7.1	4.5
Sustainment	289.4	270.6	180.7	205.0	165.3
SRA Costs					119.7
Total	291.0	376.9	365.3	418.0	391.3

As shown in Figure 5 and as in the LCC comparison, the lowest cost of all the alternatives, regardless of the life cycle period, is to retain the current EETF with the ECP185(R)2 upgrade. Two of the IFTE alternatives (IFTE with new EOB and IFTE with a dual work station) are converging on the EETF as the life cycle period is increased. However, the rate of convergence is such that the break-even point is some time after 25 years. The IFTE with the current EOB is the next lowest cost at 10, 15, and 20 year life cycles, but the IFTE with the new EOB is the next lowest cost at 25 years. There is an approximate $99 million difference between the two lowest cost alternatives at 15 years and an approximate $74 million difference between the two lowest cost alternatives at 25 years. For the 10-year analysis considering immediate fielding as well, there is an approximate $95 million difference between the two least cost alternatives. In any case, the cost differences between EETF and IFTE remain significant and the EETF is still the preferred alternative.

4.3.4 Dedicated vs. Shared Support. In the LCC comparison, it is assumed that the Apache support structure requires dedicated ATE, regardless of whether it be EETF or IFTE. Based on the anticipated Apache workload (see Figures 1 and 2) and the current deployment of EETF's (see Table 1), it appears that the Apache fleet requires approximately 70 percent of the total ATE capacity offered by 21 of the 22 tactical EETF's and the 21 IFTE's. Because IFTE will be used to support several systems, there is a possibility that 30 percent of the total capacity of IFTE assets could be shared with other systems. In that case, some of the IFTE costs could also be shared with other systems. The following analysis addresses the sensitivity of the LCC comparison to assumptions concerning dedicated versus shared ATE support.

Some of the IFTE costs are solely attributable to the Apache and, therefore, would not be shared with other systems. Table 16 shows the categories of cost that are accrued for IFTE hardware that can be shared (Shrd), are peculiar to Apache only (Pec), are sunk costs (Sunk) or are not applicable (N/A) to this analysis (N/A costs are not included in the LCC comparison).

Table 16. SHARED VS. NON-SHARED COSTS.

		IFTE						
Cost Category	Interim EETF	BSTS	APE	Old EOB	New EOB	TPS	Floor Mtd	Dual Station
Development	Sunk	Sunk	Sunk	Sunk	Sunk	Pec	Sunk	Sunk
Production	Sunk	Shrd	Sunk	Sunk	Shrd	Pec	Pec	Shrd
Fielding	Pec	Shrd	Sunk	Sunk	Shrd	N/A	Pec	Shrd
Sustainment	Pec	Shrd	Pec	Pec	Shrd	N/A	Pec	Shrd

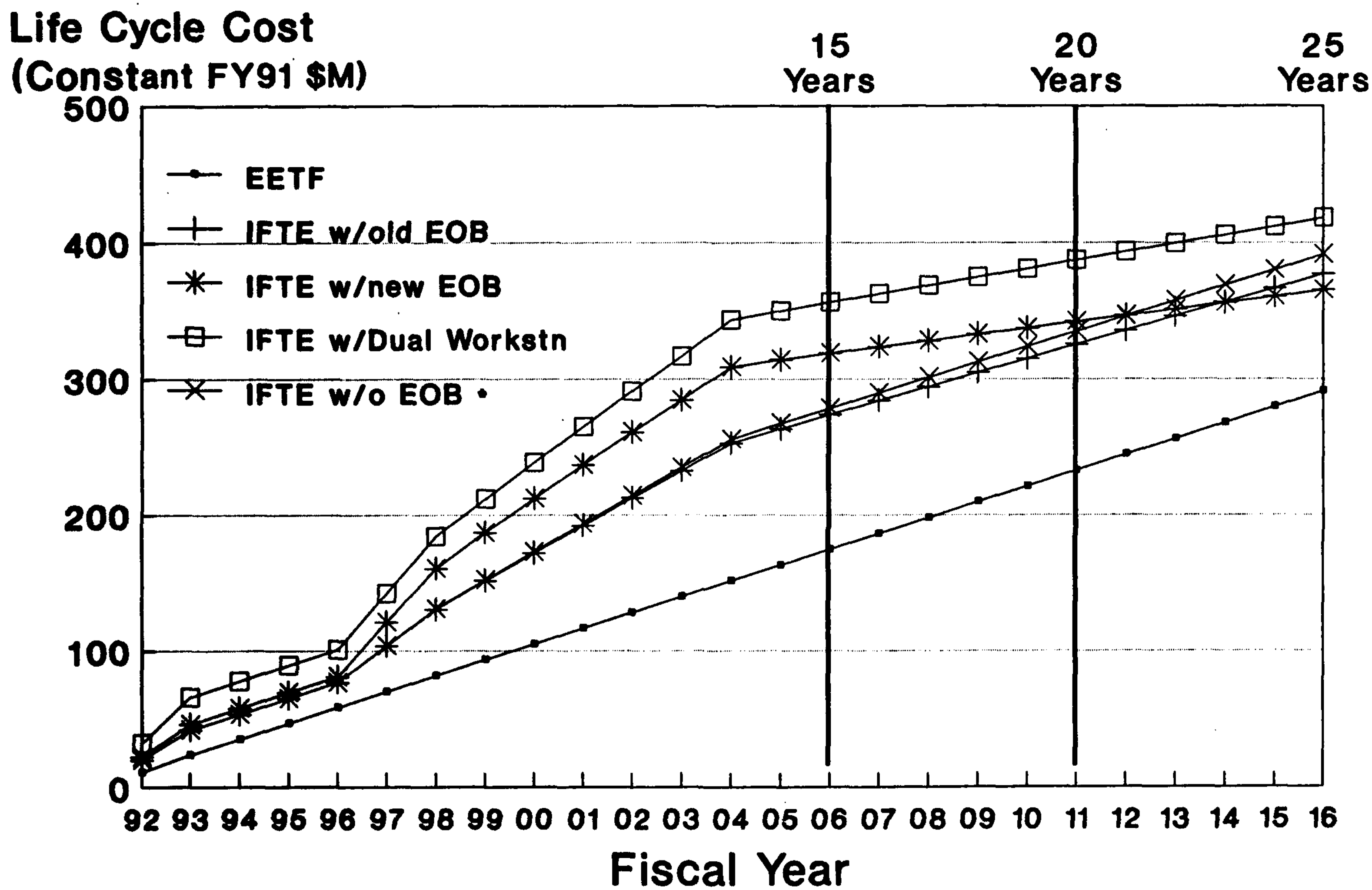

Figure 5. Sensitivity to Life Cycle Period

As suggested in Table 16, only specific hardware can by shared among systems while other hardware items are peculiar to the support of Apache and are not capable of being shared. In this analysis, appropriate cost elements for those items of hardware that can be shared are allocated to other systems based on the percentage of ATE capacity that is shared. For example, for the IFTE with the New EOB, 70 percent of the Production, Fielding, and Sustainment costs are attributed solely to Apache and 30 percent of the costs are allocated to other systems. At the same time, the EETF is assumed to be an interim system to the IFTE alternatives. This implies that while some EETF's are being replaced by IFTE's, other EETF's are still being sustained until the transition to IFTE is completed. (Reference Table 4 and Section 3.2 for production and delivery schedules used in the LCC comparison.) EETF sustainment costs are Apache peculiar costs that are incurred throughout much of the life cycle for the IFTE alternatives. APE hardware as well as floor mounted IFTE's are also dedicated to the support of Apache. Because of their peculiar support to the Apache, these cost elements are not allocated to other systems.

Table 17 shows the LCC results if the remaining 30 percent of the IFTE capacity is shared with other systems.

Table 17. SENSITIVITY TO SHARED SYSTEM SUPPORT.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	36.5	18.3
Production	0.0	71.9	127.4	133.9	71.9
Fielding	1.6	3.9	5.8	5.8	3.9
Sustainment	231.3	186.6	143.1	154.8	135.7
SRA Costs					81.7
Total	232.9	280.7	298.8	331.0	311.5

As shown, the least cost of all the alternatives, as in the LCC comparison, is retaining the current EETF with the ECP185(R)2 upgrade. Again, the IFTE with the current EOB is the least cost of the IFTE alternatives. There is an approximate $48 million difference between the two least cost alternatives which translates to a 21 percent difference.

Figure 6 shows the sensitivity of LCC results to the sharing of ATE assets at various capacity levels of use by Apache. In this analysis, the sum of peculiar costs and the portion of shared costs allocated to Apache are shown as a function of the percentage of ATE capacity that is used to accomplish the Apache workload. As shown, Apache usage would have to be 40 percent or less in order to make IFTE competitive. Since it is anticipated that Apache requirements for ATE will be for at least 70 percent of capacity, this analysis does not change conclusions on EETF.

4.3.5 Floor Mounted EETF's - Replace or Not. In the LCC comparison, it is assumed that nine of the fourteen floor mounted EETF's will be replaced by seven IFTE CEE's and two ATSE work stations. It is believed that this is necessary in order to continue obtaining TPS development and support from the contractors, providing Apache training support and providing an AVIM capability at CCAD. This subject created much controversy as to whether or not any of the floor mounted EETF's need to be replaced with dedicated IFTE assets. In this sensitivity it is assumed that the contractors would procure and sustain their own floor mounted IFTE's and that the training and CCAD support would be provided by the generic electronic maintenance concept thereby providing support to many systems at once. In other words, none of the floor mounted EETF's would be replaced with dedicated IFTE assets. Table 18 shows the total LCC of replacing only the 22 tactical EETF's with IFTE's.

Table 18. SENSITIVITY TO REPLACING TACTICAL EETF'S ONLY.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	63.0	125.5	131.8	63.0
Fielding	1.6	3.8	6.1	6.1	3.8
Sustainment	231.3	214.5	154.4	171.0	144.1
SRA Costs					81.7
Total	232.9	299.6	308.5	351.4	310.9

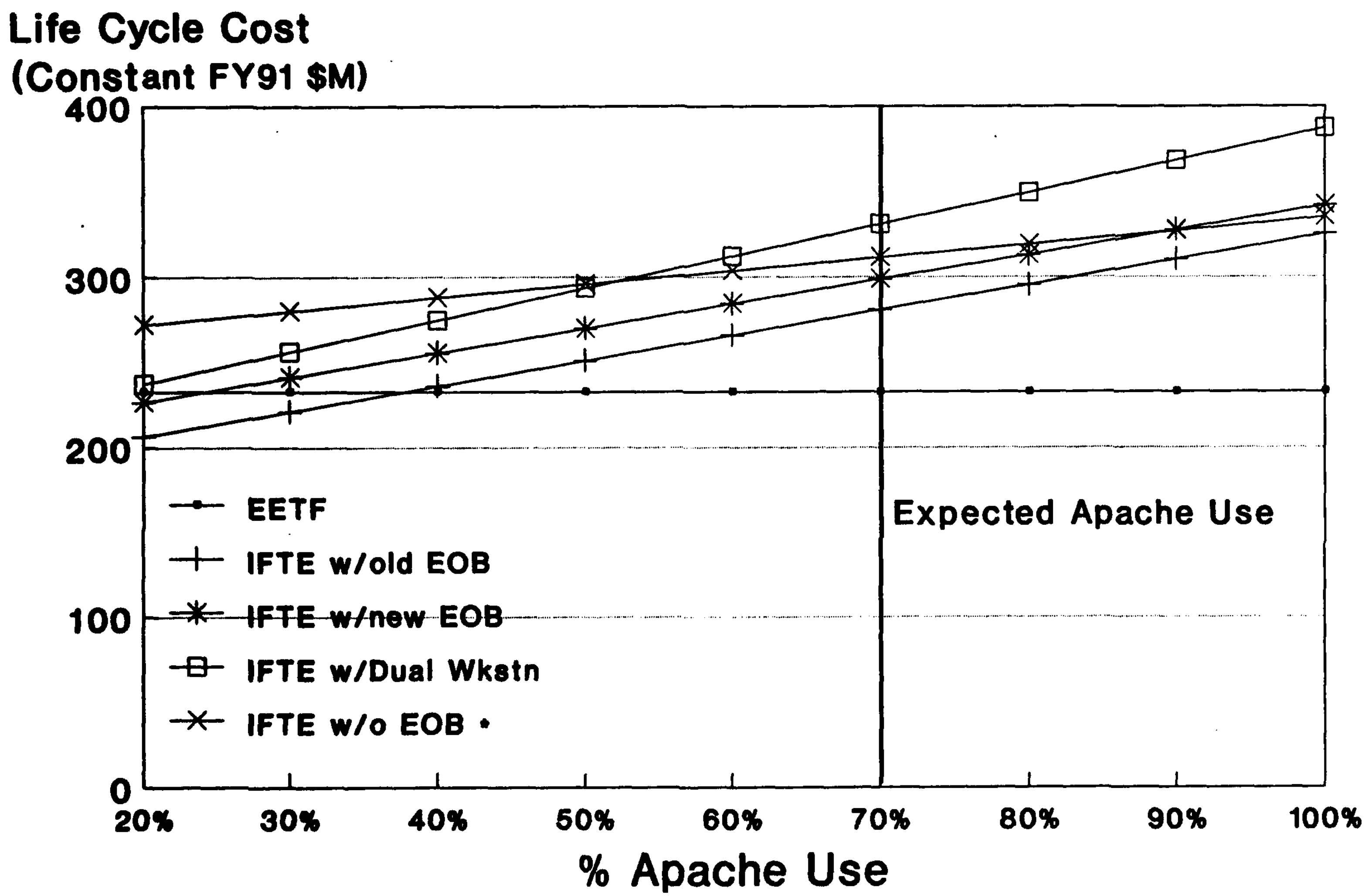

Figure 6. Sensitivity to
Shared System Support

As shown, the lowest cost alternative, as in the LCC comparison, is to retain the current EETF with the ECP185(R)2 upgrade. The IFTE with the current EOB is the lowest cost of the IFTE alternatives. There is an approximate $67 million difference between the two least cost alternatives translating to a 29 percent increase in cost over the EETF. This same IFTE alternative (with current EOB) is $26 million less in this sensitivity analysis than in the base case. This suggests that the cost of the floor mounted IFTE replacements is only about eight percent of the total LCC. In any case, the ranking of EETF vs IFTE is unchanged by the assumptions regarding the replacement of floor mounted EETF's. EETF is still the referred alternative.

4.3.6 Retention of Apache Peculiar Equipment. There are many differences in opinion as to the amount of APE which must be retained if IFTE is used in support of Apache. The opinions range from all the APE being required by IFTE to no APE required by IFTE. The AVSCOM ATE Center gave a definitive answer based on a comparison of capabilities and capacities between EETF and IFTE. They were able to specify which of the items should be retained and which were not necessary (see Section 6.3). Nevertheless, no one was able to breakout the costs that are attributed to each individual hardware item. In the base case analysis, it is assumed that 25 percent of the total sustainment costs for APE is appropriate for retaining APE for use with IFTE. This sensitivity analysis assumes that no APE will be required by IFTE to support Apache. Results are displayed in Table 19.

Table 19. SENSITIVITY TO NOT RETAINING APE.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	83.5	155.0	163.4	83.5
Fielding	1.6	4.5	7.1	7.1	4.5
Sustainment	231.3	217.4	155.9	172.6	146.0
SRA Costs					81.7
Total (no APE)	232.9	323.7	340.5	385.6	334.0
Base Case (25% APE)	232.9	325.3	342.0	387.1	335.0
100% APE	232.9	330.0	346.6	391.6	337.6

As shown, deleting the requirement to retain APE does not change the costs by a significant amount. Even if 100 percent of the APE sustainment costs had been included in the base case, deleting the requirement to retain APE does not make a significant difference. In any case, the relative ranking of alternatives remains the same and EETF is still the preferred alternative.

4.3.7 Residual Value. In the base case LCC comparison, it is assumed that neither the IFTE nor EETF will have any value after Apache use (after 2011). However, it has been suggested that the IFTE assets could possibly be transferred to support other systems after the Apache is done with them. This would imply that these assets would have some residual value after Apache use. The question is, what value should be assigned to IFTE. The EETF assets would not be transferable because of their capabilities being peculiar to the support of Apache and would have no significant value other than scrap.

A sensitivity analysis is conducted in order to determine the impact of any IFTE residual value at the end of the life cycle period. A straight line depreciation technique is used, based on the remaining life of IFTE, to estimate its residual value. IFTE is assumed to have a 20 year useful life cycle. The remaining years of useful life after Apache use for each individual asset is determined based on the difference between twenty years and the number of years used in the field for Apache. This estimate is then divided by the number of years in the life cycle period and multiplied by the unit manufacturing price for IFTE at the end of the life cycle period. These estimated residual values are considered a credit and subtracted from the results of the LCC base case (see Table 9). These results are displayed in Table 20.

Table 20. SENSITIVITY TO RESIDUAL VALUE.

Costs		EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
		Costs (Constant FY91 $M)				
Development		0.0	18.3	22.5	42.5	18.3
Production	A	0.0	83.5	155.0	163.4	83.5
	B	0.0	84.0	155.4	163.8	84.0
	C	0.0	86.6	158.0	166.4	86.6
	D	0.0	91.8	163.2	171.6	91.8
Fielding		1.6	4.5	7.1	7.1	4.5
Sustainment		231.3	219.0	157.4	174.1	146.9
SRA Costs						81.7
Total	A	232.9	325.3	342.0	387.1	334.9
	B	0.0	325.8	342.4	387.5	335.4
	C	0.0	328.4	345.0	390.1	338.0
	D	0.0	333.6	350.2	395.3	343.2
Credit for Residual Value	A	0.0	17.2	40.9	44.7	17.2
	B	0.0	18.3	42.1	45.9	18.3
	C	0.0	19.5	43.3	47.1	19.5
	D	0.0	21.9	45.6	49.4	21.9
Total	A	232.9	308.2	301.1	342.3	317.8
	B	0.0	307.4	300.3	341.6	317.0
	C	0.0	308.9	301.9	343.0	318.5
	D	0.0	311.7	304.6	345.9	321.3

As shown, the residual value as computed by the above method is approximately one fourth the original total production cost. This is because the procurement of TPS's/ICD's account for a major portion of the production costs, about one half of the useful life of IFTE on the average is consumed for support of Apache and there are other production cost elements that would not be recouped in any way. As in the base case, the lowest cost of all the alternatives in this sensitivity analysis is to retain the current EETF with the ECP185(R)2 upgrade. The lowest cost of the IFTE alternatives has switched to the alternative with the new EOB. In this sensitivity, IFTE configuration B is less costly than configuration A by a small margin. In any case,

considerations for residual value do not affect the relative ranking between EETF and IFTE leaving the EETF as the preferred alternative.

4.3.8 Inflation and Discounting. In the base case and all the above sensitivity analyses, the cost estimates are presented in constant FY91 dollars. This is done to reflect the buying power of todays dollar and to avoid introducing errors in estimating inflation for outyear expenditures. In the following analyses, the base case is analyzed to determine its sensitivity to both the buying power of the dollar as it is eroded by inflation and to the present value of dollars expended in the future (discounting).

These sensitivities are estimated independently of each other. Inflation rates, obtained from the 7 January 1991 AMC Memorandum entitled Inflation Guidance (reference 21) are applied to the base case. Discounting rates, from AR 11-18 (reference 22), are similarly applied. Results are displayed in Table 21 for both inflation and discounting. The IFTE results are representative of configuration A only.

Table 21. SENSITIVITY TO INFLATION AND DISCOUNTING.

	Costs (Constant FY91 $M)				
Costs	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	83.5	155.0	163.4	83.5
Fielding	1.6	4.5	7.1	7.1	4.5
Sustainment	231.1	219.0	157.4	174.1	146.9
SRA Costs					81.7
Total	232.9	325.3	342.0	387.1	334.9
Total w/Inflation	349.7	470.2	473.9	536.0	486.9
Total w/Discounting	94.6	142.5	161.1	185.3	144.8

In both cases, as in the base case, the lowest cost alternative is to retain the EETF with the ECP185(R)2 upgrade. The ranking of alternatives is unaffected and the EETF is still the preferred alternative.

4.4 Summary.

Table 22 displays the ranking of the alternatives, based on least cost, for the LCC comparison and each of the sensitivity analyses. The lowest cost alternative is represented by a 1, the most costly with a 5.

Table 22. RANKING OF ALTERNATIVES.

Analysis	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
LCC Comparison (base case)	1	2	4	5	3
Earlier & More Rapid Proc.	1	3	2	5	4
ATE Requirements					
Peacetime (16 vs 21)	1	2	4	5	3
Wartime (55 vs 21)	4	3	2	5	1
Life Cycle Period					
10 years	1	2	4	5	3
15 years	1	2	4	5	3
25 years	1	3	2	5	4
Shared vs. Non-Shared Supp.	1	2	3	5	4
Floors - Replace or Not	1	2	3	5	4
No APE	1	2	4	5	3
Residual Value	1	3	2	5	4
Inflation	1	2	3	5	4
Discounting	1	2	4	5	3

In all except one of the sensitivity analyses, as in the LCC comparison, the lowest cost alternative is retaining the current EETF with the ECP185(R)2 upgrade. The one exception is when the quantity requirement for ATE is dependent on wartime requirements. In this case, two of the IFTE options are less costly than EETF, the lowest cost being IFTE without an EOB and the next lowest cost being the IFTE with its new EOB. The other two IFTE options are also competitive with EETF in this case. In the majority of the sensitivity analyses, the IFTE with the current EOB is the next lowest cost alternative. Otherwise, the IFTE with the new EOB is the next lowest cost alternative. For all of the IFTE alternatives, configuration A is the lowest cost configuration for housing the BSTF, in most cases, with the exception of the sensitivities to wartime requirements (configuration D) and residual value (configuration B). Configuration A is also the least cost configuration for the LCC comparison.

The relative costs for each of the alternatives are calculated using the baseline alternative, retaining the EETF, as the basis. Relative costs are calculated for the baseline LCC comparison as well as each of the sensitivity analyses. Because configuration A, retaining the two EETF vans,

is the least costly IFTE configuration for all of the sensitivities, with two exceptions, its cost is the one represented in Table 23 for all except the sensitivities to residual value and wartime requirements which are based on configurations B and D, respectively.

Table 23. RELATIVE COST.

Analysis	EETF with ECP185	IFTE w/EETF EOB	IFTE w/New EOB	IFTE w/Dual Work Station	IFTE w/o EOB
LCC Comparison	1.00	1.40	1.47	1.66	1.44
Earlier & More Rapid Proc.	1.00	1.35	1.20	1.45	1.44
ATE Requirements					
Peacetime (16 vs 21)	1.00	1.46	1.52	1.75	1.49
Wartime (55 vs 21)	1.00	0.99	0.89	1.00	0.71
Life Cycle Period					
10 years	1.00	1.80	1.99	2.36	1.89
15 years	1.00	1.57	1.82	2.04	1.59
25 years	1.00	1.30	1.26	1.44	1.34
Shared vs. Non-Shared Supp.	1.00	1.21	1.28	1.42	1.34
Floors - Replace or Not	1.00	1.29	1.32	1.51	1.33
No APE	1.00	1.39	1.46	1.66	1.43
Residual Value	1.00	1.32	1.29	1.47	1.36
Inflation	1.00	1.34	1.36	1.53	1.39
Discounting	1.00	1.51	1.70	1.96	1.53

As shown, the relative costs, as presented here, represent the percentage increase in costs over the baseline alternative to pursue each of the IFTE alternatives. The costs for IFTE are significantly greater than continuing with EETF, in every case, except for buying ATE systems to meet the wartime requirement. The cost disadvantage for the lowest cost IFTE alternative in these cases ranges from 20 percent higher than EETF to 80 percent higher. The average is approximately 40 percent higher. In the case of buying ATE to meet wartime requirements, two of the IFTE options cost significantly less than EETF including the IFTE without EOB at 71 percent of the EETF's cost and IFTE with the new EOB at 89 percent of EETF costs.

5. BENEFITS

The main purpose of the development and fielding of the IFTE program is to provide standardization of ATE for the support of all Army electronic systems and commodities. The capabilities and capacity of IFTE will be enhanced even further by the implementation of the generic electronic maintenance concept. At the same time, there are a number of advantages for continuing to support Apache with the EETF. Finally, there are a number of disadvantages for each of the alternatives. Unfortunately, there are no

concrete data from tests nor experience to quantify and measure the benefits of IFTE. However, various observations can be made. The following sections provide a subjective assessment of the benefits of transitioning to IFTE and the advantages and disadvantages of each of the alternatives considered.

5.1 EETF with ECP185(R)2.

The many advantages and disadvantages of continuing to support the Apache with the EETF with the ECP185(R)2 upgraded computer are summarized as follows:

Advantages,
- ECP updates computer to 1980s technology,
- ECP improves capability,
- ECP extends supportability indefinitely, and
- No disruption of Apache support.

Disadvantages,
- Remaining ATE - 1960s technology, and
- Maintain training base for system specific MOS.

5.1.1 Advantages. The upgrades made to the EETF computer and control and display subsystems with the MV7800 series computer bring the EETF automatic data processing capability up to 1980s vintage technology. This is nearly in line with the current technology level of the basic IFTE BSTF which is also 1980s vintage. The ECP185(R)2 replaces obsolete control/display subsystem equipment (i.e., disk drive, tape drive, and video display terminal) with upgraded current control/display subsystems. The new computers in both the EETF and the IFTE are 32 bit machines, are faster, have extended memory, have increased disk storage capacity and can be maintained more easily given their modular design. These improvements are important since they allow for faster TPS runtimes, more data storage and better maintainability. Although the IFTE also has several user enhancements in its design which greatly improve user friendliness over the EETF, PM-Apache has reported that, based on EETF crew comments, the EETF equipment is more powerful and can do more things. Another advantage of the ECP is that the upgraded computer extends maintenance and parts supportability for, as the contractor states, as long as the Army needs it. The EETF EOB and APE are still of late 1970s/early 1980s vintage technology, but obsolescence is not seen to be a problem with these hardware items. One other big advantage of continuing on with the EETF is that the support of the Apache fleet will not have to be disrupted by any transition process. Transitioning to IFTE would require several EETF's to be pulled out of their respective AVIM's and sent to TOAD in order for the old ATE to be removed from the vans and the new IFTE BSTS to be installed. This disruption of ATE availability could impact significantly on the accomplishment of workload at the respective AVIM's.

5.1.2 Disadvantages. Originally, the main disadvantage of continuing to use the EETF to support Apache was the use of the old EQUATE computer system. This computer was of 1960s vintage technology and the contractor could no longer support it. The ECP185 was implemented to upgrade this computer to a more current version. Nevertheless, several of the

original components will remain in use in the EETF as follows: the printer, the Direct Current (DC) power station, the Programmable Interface Unit (PIU) station, and the Unit Under Test (UUT) station. It is understood, however, that these items will be upgraded as needed at the component level through a recurring sustaining engineering effort and will not involve any major engineering changes (See Section 4.6.3 for further discussion of this topic).

Another disadvantage of continuing with the EETF is the need to continue with the advanced individual training base for a system specific MOS (39BX). The separate EETF facility now used at OMMCS for the hands-on training will continue to be required. Separate instructors and all the associated indirect support costs will continue to be required. The length of training for each student is significantly greater than for IFTE (44 weeks vs. 30) contributing to higher sustainment costs. It is understood that when the Apache system was granted a waiver allowing total Army fielding of the EETF and implementation of the ECP185, crew training was not properly coordinated and, as a result, the training for military operators for the EETF ceases in FY97. If EETF continues to be used to support Apache, then funds will have to be provided to support this system specific training base.

5.2 IFTE Advantages.

The benefits of standardizing the ATE to IFTE are summarized as follows:

Standard ATE:
- Multi-system/commodity support
- Reduced logistics burden and stockage requirements
- Greater ATE availability
- Improved EO capability
- More transportable (with S-280)
- Nuclear, Biological and Chemical (NBC) protected (with S-280)
- Reduced training requirements

Technology gains:
- 1980s technology
- Modular design
- 32 bit computer
- Extended memory
- Pinless interface
- Virtual Instrumentation

User enhancements:
- Touch screen
- Menu driven
- Color graphics
- Paperless technical manual

Other:
- Use of old EETF EOB:
- Earlier deployment potential
- Dual work station capability

Use of new EOB:
Realization of above benefits
Dual work station:
Computer sharing for testing two LRU's simultaneously
IFTE without EOB:
Development and procurement of EOB eliminated

5.2.1 Standardization. The benefits relating to the standardization of ATE and to generic electronic maintenance are summarized as follows:

5.2.1.1 Multi System/Commodity Support. The value of standardization is the ability to support more than one system. In this case, the IFTE is designed to provide multi-system/commodity support. Funds are identified for the Hawk system, Multiple Launch Rocket System (MLRS), Single Channel Ground and Airborne Radio Subsystem (SINCGARS), the Army Howitzer Improvement Program (AHIP), the Gunners Primary Sight (GPS), the Tube-launched Optically-tracked Wire-guided (TOW2) missile system on the Bradley Fighting Vehicle, and others. Many other systems/commodities are under consideration.

5.2.1.2 Logistics Burden. The value of standardization is also seen in improved interoperability and maintainability of components and in reduced stockage requirements and logistics costs. In the future, more and more electronic equipment will be fault isolated via the IFTE BSTF. The Apache IFTE, while having additional Apache peculiar capabilities, should be capable of fault isolation of non-Apache electronic equipment if needed. The main consideration is the geographical locations of Apache units, dedicated ATE and other potential system users. Obviously, other systems using the Hellfire system and perhaps other aircraft units could be supported. The results of the previous AMSAA study of Apache ATE supported the transition to IFTE mainly for the increase in benefits. These benefits are acknowledged for the IFTE program and for the systems supported if standardization is imposed.

5.2.1.3 Availability. The ECP185(R)2 for the EETF consists of replacing the old EQUATE S-130 computer with an MV7800 series computer provided by General Electric (GE). The company providing the computer claims they will support the system for as long as the Army requires it. However, the computer system which was originally being proposed is not the system which is being implemented. Instead, even before the original upgrade computer could be completely tested and inducted into the Army, it was discontinued and replaced with a more advanced computer. Although this is a symptom of the pace of electronic technology development, the long term availability of a low density system such as ECP185(R)2 is more questionable than for a higher density system such as the IFTE. It is also understood that the IFTE is expected to be more reliable than the EETF. Greater reliability translates into greater operational availability to accomplish the workload. Unfortunately, recent test data do not indicate higher reliability for IFTE, but reliability growth can be expected as the system matures.

5.2.1.4 EO Capability. No data are available to compare the capabilities of the new EOB for IFTE to the EETF EOB. It is assumed that it is at least as capable as the EETF EOB. However, the IFTE program will

provide improved EO capability as a result of using one standard EOB to support many systems/commodities. Fault isolation of EO LRU's will improve from the greater experience received from testing a greater variety of LRU's.

5.2.1.5 Transportability. The basic IFTE BSTF is installed in an S-280 shelter mounted permanently on the bed of a five ton truck. This allows for much quicker tear-down of the BSTF for transport, moving to the new site, and much quicker set-up again for operations. This, in turn, allows for much improved battlefield utilization. If the transition of Apache to IFTE means installing the BSTS and other equipment in the original EETF vans, the benefit of transportability goes away.

5.2.1.6 NBC Protection. Another benefit of the basic IFTE BSTF with the S-280 shelter is NBC protection. This protection allows for the crew to perform their duties without wearing NBC protective clothing. This again allows for much improved battlefield utilization. Currently, the vans used for the EETF are not NBC protected. In fact, the EETF vans allow dust and sand to enter the facility which creates problems with computer operation. Again, if the transition of Apache to IFTE means installing the BSTS in the EETF vans, these benefits will be negated.

5.2.1.7 Training Requirements. Training requirements will be reduced if Apache transitions to IFTE. This reduction will come mainly as a result of the elimination of the Military Occupational Specialty (MOS) 39BX currently required for training of the EETF crew. All crews for the systems supported by IFTE will share the same MOS (39Y). The number of weeks of advanced individual training required per student will be reduced from 44 for EETF to 30 for IFTE. A dedicated ATE facility will no longer be required at OMMCS for hands-on training as is the case for EETF. Training instruction for the Apache ATE will be consolidated with that provided for all systems supported. Consolidated instruction will result in a decrease in the number of instructors required by OMMCS and a reduction in direct costs for overhead and equipment depreciation and indirect cost for base support, medical support, and family housing. Finally, the elimination of the EETF crew MOS will also reduce MOS proponency management.

5.2.2 Technological Gains. Various advantages of the IFTE BSTF can be described in terms of technological improvements. These improvements can further be translated into improved computer capabilities. However, the ECP185(R)2 upgrade to the EETF computer also provides improved computer capabilities. As noted under EETF benefits, both computers include several hardware improvements (modular design, a 32 bit computer, and extended memory) that improve data storage and increase the speed for running TPS's. The IFTE goes a step further by having high density electronic circuitry, gold dot pinless interface connectors, an optical disk system for test program software, and self test and self alignment capability. Without a doubt, the IFTE BSTS is more capable than the upgraded EETF. However, transitioning to IFTE will require all the Apache TPS's and ICD's to be re-developed in order to take advantage of these improvements. The current TPS's and ICD's have already been modified for use with the new EETF computer.

As noted, the workload for the Longbow (series C) model decreases considerably from the workload for the A and B series. This is largely due to a much reduced number of LRU's to be tested for the Longbow thereby requiring fewer TPS's and ICD's. However, given that changes are expected, the future Apache ATE will have to be adaptable to those changes for it to remain mission capable. The IFTE ATE provides virtual instrumentation on cards. These cards share a bus to other instruments and, through design of TPS's, can be reconfigured to perform certain needed functions. This improvement in instrumentation, in some cases, can replace the need for dedicated instruments. Based on discussion with a PM-TMDE engineer, however, this virtual instrumentation would not be practical or could not be used in most cases to replace the capabilities necessarily provided by the current APE on the EETF. Regardless, this improvement offered by the IFTE provides for increased testing flexibility and growth for new technological changes to the Apache system.

5.2.3 User Enhancements. User enhancements built into the IFTE computer include such things as a touch screen and color graphics display with menu driven instructions. These enhancements allow for much improved use and operation of the available software. The IFTE computer also includes a "paperless" technical manual to provide for on-board user fault isolation "help" instructions and system maintenance instructions. All these things make the IFTE system much more user friendly for the crew than the EETF.

5.2.4 Other Advantages. Other advantages that can be attributed to the various alternative IFTE configurations considered in this study are summarized below.

5.2.4.1 Use of Old EOB. Current funding schedules developed by OMMCS show the production and fielding of IFTE to support aviation systems to begin in FY97 and FY98, respectively. If funds were made available, IFTE could be fielded much earlier for Apache. However, the new EOB being developed by the Navy and incorporated into the IFTE will not be available until FY94. By retaining the current EETF EOB to be used with IFTE, the fielding of IFTE for Apache could be even earlier. Overall production costs would be reduced and the EO TPS's would not have to be re-developed. Regardless, TPS development would take approximately two years, so that fielding of IFTE for Apache may not be desired before FY94 at the earliest. Moreover, the Apache may as well benefit from the ECP185(R)2 upgrades since the contract cannot be terminated.

One draw back of retaining the old EETF EOB is that, in its current configuration, it is not compatible with the IFTE computer. It will either require a separate computer in order to operate properly or a major redesign/reconfiguration effort in order to integrate the EOB with the IFTE computer and ATE. In this study, it is assumed that the least cost and least disruptive approach will be to retain the upgraded EETF computer for use with the EOB. One added benefit of retaining a separate computer is that the IFTE would then have a dual work station capability and would be capable of testing two LRU's at once.

5.2.4.2 Use of New EOB. The greatest advantages that can be attributed to IFTE are those benefits that are accrued from standardization,

technological gains and user enhancements. Not all of these benefits, however, will be fully realized without the new EOB. If the decision were made to retain the old EETF EOB or to develop a dual work station capability for support of Apache, the IFTE provided for Apache would no longer be a standard ATE facility.

5.2.4.3 Dual Work Station. The main advantage of the dual work station design is the capability to test two LRU's simultaneously. The two work stations would share the same computer through a time sharing method. The advantage would be one of accomplishing a greater workload in the same time period.

5.2.4.4 IFTE Without EOB. As shown in Figure 1, about 75 percent of the workload is fault isolation of TADS/PNVS EO LRU's. If these LRU's were sent directly to the SRA's for testing and repair, there would no longer be a requirement for an EOB in the ATE facility. This would significantly reduce the workload for the ATE and the associated sustainment costs. It would also increase its availability to test the remaining Apache peculiar and radio frequency LRU's.

5.3 IFTE Disadvantages.

The many disadvantages attributed to the IFTE alternatives and fielding options considered in this study are summarized as follows:

Use of S-280 shelter:
- Inadequate space for APE and EOB
- Limited working space

Use of EETF vans:
- Requires major engineering effort
- Requires pulling EETF's out of field

Use of old EOB:
- Requires separate computer or hardware modifications
- May require pulling EETF's out of field

IFTE with dual work station:
- Inadequate space in S-280 shelter

IFTE without EOB:
- SRA workload increased
- NEOF's undetected before maintenance
- OST and floats increased
- Changes Army maintenance concept
- Stock funding impact on Apache units

5.3.1 Use of S-280 Shelter. The S-280 shelter, which is currently used to house the basic IFTE BSTS, is much smaller than the EETF van (see pictures of both in Appendices A and B). It is only about half as long as the EETF van and its sides are not expandable like the van. It is planned to put the EOB in the standing space at the front of the shelter which would take

away from available working space. The APE items that must be retained will also take some space. The basic IFTE BSTF configured without an EOB is already cramped for space. There is inadequate space in the S-280 shelter for the BSTF, the EOB, and the retained APE, a separate shelter will be required for the EOB and APE.

The S-280 shelter also has limited space for worker maneuverability and handling of LRU's to be tested. Even with the EOB and APE housed in a separate shelter, the space available for worker maneuverability is limited. The EETF van has much more space for the workers to maneuver the LRU's for testing.

5.3.2 Use of EETF Vans. As discussed in Section 4, putting the IFTE BSTS in the current EETF vans will require major engineering and installation efforts. An engineering evaluation will have to be conducted in order to plan for the removal of the current ATE and for determining the configuration of ATE in the EETF van. The installation of IFTE in the vans will be conducted at TOAD. This installation will require pulling several EETF's out of the field at once. Installations will occur as the IFTE BSTFs are fielded. Assuming the schedules as proposed in this study are correct, the removal of EETF's out of the field for IFTE installation will occur over an eight year period from FY98 through FY2005. This in turn will affect the availability of ATE at each AVIM to accomplish the available workload.

5.3.3 Use of Old EOB. It is understood that the EETF EOB is not compatible with the IFTE computer. Compatibility problems concern the interface hardware and language differences between the internal EOB computer and the IFTE computer. If the EETF EOB is retained to use with the IFTE BSTF, it would require either a separate computer for operation of the EOB or a major engineering effort to redesign/reconfigure the computers in order to interface properly. The first option could be accomplished by also retaining the upgraded Core-410 computer to operate the EOB. This would require additional space and incur a penalty in higher sustainment costs than the new Navy developed EOB currently planned for IFTE. The second option would require additional funds for the engineering effort involved and additional costs for the modification and procurement of new TPS's/ICD's for testing EO LRU's. In either case, the retention of equipment and the integration with IFTE equipment would probably also require pulling several EETF's out of the field at once to accomplish the transition to IFTE. This presents the same problems as suggested above.

5.3.4 Dual Work Station. The only disadvantage seen with the dual work station is again the limited space available for worker maneuverability in the S-280 shelter. Two work spaces with test stations can be created in the S-280 shelter, as shown in Appendix B, but the workers in the front station would need to climb over the others or have them move out of the way in order to maneuver the LRU's into place for testing.

5.3.5 IFTE without EOB. Several disadvantages would be realized if the IFTE were fielded for the Apache without an EOB. First, all the TADS/PNVS (EO) LRU's would need to be sent directly to the SRA's for testing and repair. About 25 percent of these are currently repaired at the AVIM

level. Testing of EO LRU's requires about 75 percent of the total EETF workload. Therefore, the SRA's would realize a marked increase in testing and repair workload and would need to be expanded in order to accomplish the workload on a timely basis. (The cost of the additional SRA workload is included in the cost analysis.)

Secondly, a large number of LRU's (about 30 percent) are falsely pulled from the aircraft as a failed item when in fact there is no failure. When the item is tested, there is a NEOF indication. Without the EOB, these NEOF's will not be detected until the item is tested by the SRA (depot level maintenance). By going undetected until SRA maintenance, the return of these LRU's to the supply point is delayed.

Thirdly, the turn around time from the point of pulling the LRU off the aircraft to the return of a repaired LRU to the supply point will be increased since the LRU will have to go to the SRA for testing. This increase in the turn around time will also affect the availability of spare LRU's at supply points (maintenance floats). Therefore, the quantity of spare LRU's in these floats will more than likely need to be increased if the IFTE is fielded without an EOB.

Fourth, the return of all EO LRU's to the SRA's for test and repair will require a major change in the Army maintenance support structure. As shown in Figure 1, a major portion of the workload is EO in nature. If this workload were directed to the SRA's, the workload at the current ATE's would be reduced considerably to the point where many EETF's would be underutilized. The impact of this is unknown.

Finally, with the implementation of Stock Funding for Depot Level Reparables, units will soon be required to supply the funds for getting repairs accomplished at depot levels. The SRA's are at the depot level and their workload will be increased significantly with the additional EO LRU's being directed to them. Consequently, there will be a major impact on the funds required by Apache units to get repairs accomplished at the SRA's.

5.4 Summary.

While the advantages of fielding a standard ATE for the support of Apache appear worth while, the disadvantages attributed to IFTE are significant. IFTE with its technologically advanced computer will provide potentially faster speed for LRU testing and extended memory for increased storage of data. The IFTE also provides user enhancements that appear to offer much greater user friendliness. The EETF computer, however, is also being upgraded and will have many of these same benefits. On the other hand, some of the common equipment advantages of IFTE will not be totally realized since the Apache and aviation units are specifically excluded from the generic electronic maintenance concept. The disadvantages of transitioning to IFTE are dependent largely on the need to use the EETF van for housing the IFTE BSTF. This necessity requires pulling several EETF's out of the field at once which reduces availability of the necessary ATE to accomplish the workload. This reduced availability would occur over a lengthy time period (FY98 through FY2005). Finally, the resulting BSTF, with the retention of APE and the use

of the vans, will no longer be standard hindering the potential for sharing of assets with other systems. Overall, it appears that the disadvantages of transitioning to IFTE out-weigh the advantages.

6. CONCERNS - USATMDEA AND OMMCS

A pre-brief of the results of this study was presented to USATMDEA in July 1991. Other agencies represented were the PM for TMDE, the Combined Arms Support Command (CASCOM), OMMCS, and PM Apache. Several concerns with the AMSAA study were voiced. The Director, USATMDEA and the Commandant, OMMCS both prepared memorandums to AMSAA and CASCOM, respectively, which provided a review of our analysis, stated their concerns and recommended further analysis (references 23 and 24, respectively). The Commander, CASCOM, in turn, sent a letter confirming agreement with USATMDEA and OMMCS (reference 25). The overriding concern was that the conclusion of our study conflicted with the ATE policy of standardizing hardware by fielding IFTE in support of electronics maintenance. The issues identified in these messages pertain to workload, doctrine, cost, and other areas relevant to the study as outlined below:

Workload issues:
- Wartime vs. peacetime requirements
- OMMCS furnished IFTE requirements
- Peacetime workload vs. EETF requirements
- SRA repairs / EO capability

Doctrinal Issues:
- Generic electronic maintenance concept
- Sharing assets with other systems/commodities

Cost Issues:
- Replacement of floor mounted EETF's at contractors
- Replacement of EETF's at Israel and OMMCS
- Future engineering changes for EETF
- Retention of APE
- Fielding costs for six EETF
- Contractor vs organic logistics support
- EETF training base
- Procurement mode - commercial catalog vs. technical data package
- Maintenance of additional item in the inventory

Other issues:
- Time-frame for analysis
- Age difference between EETF and IFTE
- Benefit analyses

The following sections address the above issues in more detail and clarify our findings and conclusions from further investigations. The impacts they have on the results of the study are also described.

6.1 Workload Issues.

Issue #1 - Wartime vs. Peacetime Requirements: As stated by USATMDEA, "The 22 tactical systems compared in the analysis are based on peacetime requirements. The analysis should have been based on wartime requirements ---". As stated by OMMCS, "(AMSAA recommends continuing) to support Apache with a system-specific support structure which will be able to satisfy less than 20 percent of the Apache wartime requirements. --- The application of a wartime scenario indicates that the current level of EETF's can meet less than 20 percent of the Apache workload."

Findings: Our study was based on peacetime requirements for the following reasons:

(1) It has been established that PM-Apache is not allowed to procure more EETF's, even if they are given a waiver to continue with that system. Therefore, EETF procurement is limited to the current 22 tactical systems.

(2) As shown in Table 24, the wartime requirement for EETF operating three shifts per day, eight hours per shift, and seven days per week ranges from 2.6 to 5.4 systems to support every 54 aircraft. This would result in a requirement of 40 to 80 systems. More precisely, assuming a NEOF rate of 30 percent and a crew productivity rate of 85 percent and based on the current deployment of EETF's, the number of AVIM's and the number of aircraft supported by each, the number of EETF's required to support the 113 flying hour program for all 807 aircraft is 55. As seen by the TRADOC policy to limit the production of EETF's, the Army has never allowed funding ATE to these wartime requirements. If the Army were to procure to wartime requirements, there would be a large number of systems being under utilized and/or a large number of systems and crew sitting idle. Currently, the majority of the 22 tactical EETF's are being used only one shift per day, five days per week.

Table 24. PEACETIME, MOBILIZATION, WARTIME COMPARISON OF REQUIRED EETF'S.

Productivity (%)	Number of EETF's Required to Support 54 Aircraft (Availability of EETF Hardware = 90%)								
	Peacetime 2-9-5 Schedule 20 hrs/month			Mobilization 3-8-7 Schedule 70 hrs/month			Wartime 3-8-7 Schedule 113 hrs/month		
-	NEOF (%)			NEOF (%)			NEOF (%)		
	10	30	50	10	30	50	10	30	50
60	1.3	1.4	1.6	2.6	2.9	3.4	4.2	4.6	5.4
75	1.0	1.1	1.3	2.1	2.3	2.7	3.4	3.7	4.4
85	0.9	1.0	1.2	1.8	2.0	2.4	3.0	3.3	3.8
100	0.8	0.9	1.0	1.6	1.8	2.0	2.6	2.8	3.3

(3) To date, the wartime policy for EETF's has been to expand the operating schedule to 3-8-7 and expand the SRA's to support the excess workload. Based on recent performance data from the Reliability, Availability, Maintainability and Logistics (RAMLOG) testing conducted by AVSCOM at Fort Rucker and Fort Hood, a wartime flying hour program of 113 hours per month per aircraft and expected workload data, the current level of EETF's can meet nearly 50 percent of the wartime workload with the expanded around the clock schedule (see Table 25). If the wartime flying hour program is 60 hours per month per aircraft, the current level of EETF's can meet nearly 80 percent of the workload. In either case, with expansion of the SRA's, the total workload can be accomplished.

Table 25. WORKLOAD ACCOMPLISHMENT - EETF WITH ECP185.

Operating Tempo	Percent Workload Accomplishment AH-64 A&B	AH-64 C	Overall Average
Peacetime (1-8-5)			
13.3 Hrs/Mo/Acft	79.	88.	81.
20.0 Hrs/Mo/Acft	58.	68.	61.
Wartime (2-12-7)			
113 Hrs/Mo/Acft	45.	54.	47.
60 Hrs/Mo/Acft Sensitivity	75.	85.	78.

Assumptions:
EETF Availability = 90 percent.
Crew Productivity = 85 percent.
NEOF = 30 percent.

Issue #2 - OMMCS furnished IFTE requirements: As stated by OMMCS, "(The) IFTE tactical requirements were assumed to be equal to the EETF requirements. OMMCS, provided to PM-Apache, IFTE requirements that would have significantly reduced the quantity of ATE."

Findings: It is our understanding that the OMMCS estimate of IFTE requirements is based on wartime requirements and the concept of using the IFTE in a generic electronic maintenance environment. These data show a wartime requirement for EETF's of from five to nine units to support 60 aircraft. Data are based on an outdated study by AMSAA. As shown in Table 24, these requirements would be from two to six units to support 54 aircraft. Based on what little IFTE run-time data were available from support of the MLRS (only a 25 percent reduction in run-time over the EQUATE), current workload expectations and the current maintenance structure, IFTE requirements would be about the same as EETF (one per AVIM). More importantly, as mentioned above, it is not Army policy to buy ATE to wartime requirements.

Impact of issues #1 and #2: It is agreed that the performance of IFTE is equivalent or superior to EETF. Based on the above findings, if the decision is made to buy ATE to the wartime requirement (55 systems to support a 113 hour per month per aircraft flying program), than two of the IFTE alternatives become less costly than EETF (see Figure 4). In this case, this study would support IFTE as the preferred alternative. However, if the Army policy is unchanged, the current requirement quantity of 22 systems is unchanged and continuing with EETF is still the preferred alternative.

Issue #3 - Peacetime workload vs. EETF requirements: As stated by OMMCS, "The EETF requirements --- (one per AVIM) were assumed to be adequate to meet mission needs. --- EETF data --- indicate that the current level of EETF's equipped with ECP185(R)2 --- cannot meet the peacetime needs of the Apache."

Findings: Historically, the peacetime flying hour program has varied on a monthly basis from a low of four hours to a high of 19 hours per month per aircraft. The current Army standard is 13.3 hours per month. In any case, as Tables 24 and 25 show, generally, one EETF operating one shift per day, eight hours per shift and five days per week cannot meet the current peacetime workload. Based on the expected workload, the current deployment of EETF's and the number of aircraft supported by each, the current level of EETF's can accomplish approximately 81 percent of the workload for the average peacetime flying hour program of 13.3 hours (see Table 25). Based on phone conversations between the PM-Apache and each EETF site, the predominant work schedule for the tactical EETF's is one eight hour shift per day with the exception of Fort Campbell and Viesboden which are being worked two shifts per day. Fort Campbell is the only tactical EETF with an appreciable backlog (40 items). All others have a backlog of 10 or less items. Two of the non-tactical EETF's are also being worked more than one shift (two and three shifts) and they also have an appreciable backlog (30 and 90 items respectively). If the work schedule is expanded to 2-9-5 for all of the EETF's, then the one EETF per AVIM can accomplish the peacetime workload of the Apache fleet, even up to the 20 hour flying program. As noted in Figures 1 and 2, the workload decreases for the Longbow series of Apache and with the reduced throughput time achieved with the ECP185(R)2, the requirement quantity of EETF's working two shifts drops down somewhat below one per every 54 aircraft. In fact, it is the unit Commander's discretion whether to send specific LRU's to the EETF for fault isolation and repair. Many times the LRU will be sent directly to the SRA for maintenance. However, it is not because there are not enough EETF's to handle the workload.

Issue #4 - SRA repairs/EO capability: As stated by OMMCS, "A significant portion of EO LRU's --- are currently repaired at SRA's or depots. (The) added EO capability of the IFTE program was not assessed as a means to reduce current SRA/depot cost."

Findings: Both the EETF and IFTE EOB's have the capability to screen EO LRU's for fault isolation. However, based on Army policy, depot level repairs of TADS/PNVS (EO) components are made at the SRA's (depot level), not at the EETF nor at the AVIM level. Neither the IFTE nor EETF will have the capability to repair these particular LRU's. Even if the IFTE has a greater capacity than EETF, the requirement for SRA's is not eliminated.

Impact of issues #3 and #4: The number of EETF's required to meet peacetime requirements is unaffected. Current Army policy is to continue the use of SRA's for depot level repair of EO LRU's.

6.2 Doctrinal Issues.

Issue #1 - Generic electronic maintenance concept: As stated by OMMCS, "Doctrine for support of future Air Land Operations is dependent on generic electronic maintenance --- Continued proliferation of system-specific ATE applications, such as the EETF, undermine this basic electronics maintenance support concept."

Findings: According to the developer of the generic electronic maintenance company (OMMCS), aviation maintenance is specifically excluded from being supported by this concept. The Apache units are rapid deployment forces and the aviation community argues that an EETF must be available at all times to move with the unit to assure availability of maintenance support. The current maintenance structure assures this availability of maintenance. Moreover, as the generic maintenance developer states, aviation units are generally in different geographical locations than other systems, thereby making them difficult to be supported by the same maintenance company.

Impact: A one-for-one replacement of EETF's with IFTE's at the current AVIM support structure is appropriate.

Issue #2 - Sharing assets with other systems/commodities: As stated by USATMDEA, "The IFTE can be shared by different aircraft and weapon systems whereas the EETF cannot. --- the IFTE would have 17 to 67 percent of its workload capacity available to support other weapon systems in addition to Apache."

Findings: There are indeed 12 tactical systems that are apparently under utilized and, if replaced with IFTE, could be shared with other systems. The overall requirement for supporting the Apache fleet, averaged over the 22 tactical systems, is anticipated to be 70 percent of the ATE capacity. An analysis is conducted showing the sensitivity of the LCC results to the sharing of IFTE assets (see Section 4.3.4 for details). This analysis shows that Apache usage would have to be less than 40 percent to make IFTE competitive. In other words, at least 60 percent of the IFTE capacity would have to be shared in order for the costs to break-even with EETF. One reason for this is that some of the costs for transitioning to IFTE are Apache peculiar and would not be shared by other systems. Another reason is that a significant portion of alternative IFTE costs are for the EETF, which is treated as an interim system until phased out by IFTE.

Impact: The sensitivity to sharing of IFTE assets shows that, due to anticipated Apache requirements of 70 percent of ATE capacity, sharing does not change conclusions on the EETF. The ranking of alternatives is unaffected.

6.3 Cost Issues.

Issue #1 - Replacement of floor mounted EETF's at McDonnell Douglas and Martin Marietta: As stated by USATMDEA, "Replacement of some of the -- 9 or 10 floor-mounted non-tactical EETF with IFTE as shown in the briefing is not required." As stated by OMMCS, "The number of floor mounted EETF's requi-

ring IFTE replacement should be reduced from 9 or 10 to 5 or 6. The two EETF's at McDonnell Douglas --- and the two at Martin Marietta --- can be replaced with Army TPS Support Environment (ATSE) work stations."

Findings: Originally, our study was based on a one-for-one replacement of nine of the 14 non-tactical systems to include the four at McDonnell Douglas and Martin Marietta. Based on an IFTE brochure and discussions with the PM's for TMDE and Apache, it is understood that the four systems at McDonnell Douglas and Martin Marietta will be replaced with two ATSE work stations as well as two CEE's. The ATSE will be used for TPS development and the CEE will be used for TPS testing. We had originally accounted for replacing the nine systems with floor mounted BSTS's. The LCC results now include the cost of replacing nine of the 14 floor mounted EETF's with seven IFTE CEE's and two ATSE work stations. (The CEE is essentially the same as the BSTS without the shelter and truck.) In addition, an analysis was conducted showing the sensitivity of the LCC results to replacing none of the non-tactical systems (see Section 4.3.2 for details). This analysis shows a reduction in IFTE life cycle costs of as much as $40 million, but the ranking of alternatives is unaffected.

Impact: A total of 14 floor mounted EETF's will be replaced with seven IFTE CEE and two ATSE work stations. The ranking of alternatives is unaffected, even by the total exclusion of costs to replace the floor mounted EETF's.

Issue #2 - Replacement of EETF's at Israel and OMMCS: As stated by USATMDEA, "The one-for-one replacement of EETF with IFTE is not a valid concept. --- Replacement of some of the 22 tactical --- EETF with IFTE as shown in the briefing is not required." As stated by OMMCS, "Transitioning Apache support to IFTE would not require the U.S. Army to replace the EETF on lease to Israel. --- The low density of EETF operators (11 per year) can be absorbed into the existing IFTE training base, further reducing the quantity of BSTF's to 20."

Findings: The study was originally based on a one-for-one replacement of the 22 tactical EETF's with IFTE. Based on the loan agreement, the EETF on lease to Israel is scheduled for return in August 1992. Current plans are to transfer it to the Mississippi Gulfport AVCRAD to meet increased requirements as units are brought back from Europe and as the number of aircraft is increased to 807. Regardless, if for some reason Israel requests an extension on the loan, we may need to support the Israelis by replacing the EETF with IFTE.

The number of EETF operators receiving training should be around 30 per year. It is agreed that this small number of trainees could easily be absorbed into the existing IFTE training base. Therefore, a separate OMMCS training facility for Apache support is not required. In any event, the IFTE used for training at OMMCS does not yet have the EOB which would be needed for Apache training support.

Impact: Twenty one of the 22 tactical EETF's will be replaced on a one-for-one basis with IFTE.

Issue #3 - Future engineering changes for EETF: As stated by USATMDEA, "--- the 'rack and stack' --- equipment will require replacement in 13 years from the beginning of the assumed 20-year life beginning in 1992 --- (and this) is not included in the costs ---". As stated by OMMCS, "It is unlikely that ECP185(R)2 will extend the life of the EETF to FY2011 without additional ECPs. ECP185(R)2 updated the computer and display systems. The remainder of the EETF is 1960 technology fielded in the early 80's."

Findings: The Core-410 equipment is actually 1960's technology of which the computer is just now (FY91 - FY93) being replaced by the ECP185(R)2. The remaining Core-410 equipment, which is still 1960's technology, will more than likely require replacement in the near future. Based on discussion with CECOM personnel, the remaining parts of the EETF are not items which are prone to large scale obsolescence. In the past, any upgrades to the remaining Core-410 equipment have been made at the component level (relays, capacitors, etc.). These upgrades have been covered under the contract that GE has with CECOM for Core-410 support. This equipment will continue to be upgraded yearly at the component level and therefore will not require a major engineering change effort. The cost of these recurring upgrades are treated as a recurring sustaining engineering effort. The remaining equipment, including the APE and EOB, is late 70's, early 80's technology. IFTE is also 1980's vintage technology. The cost of ECP185(R)2 was approximately $25.6 million. The cost of any future upgrades for the remaining Core-410 equipment (printer, DC station, PIU station and UUT station) is estimated by CECOM to be approximately $800K per year for all 22 systems. Other potential ECPs are assumed to be equivalent in costs to those for IFTE since they are fairly close in technology.

Impact: The costs for the recurring sustaining engineering effort provided by the GE contract for support of the remaining Core-410 equipment is included in the LCC results.

Issue #4 - Retention of APE: As stated by OMMCS, "The APE was assumed to be required with IFTE. All functions required to test Apache LRU's will be incorporated into the IFTE TPS, eliminating the need for the APE except for pneumatics."

Findings: A contact at PM-TMDE had originally suggested that the current IFTE does not have the capabilities that the EETF APE has and that the APE would have to be retained. When confirmation was sought, some contacts felt that IFTE had these capabilities and others felt that it did not. On request from the AVSCOM ATE center, a comparison was made of the IFTE functional testing capabilities to those of the EETF APE. It was determined that the IFTE has equivalent capabilities to the EETF except for four components of the APE. These are: the video monitor, photometer, fiber optics probe, and the Pneumatics module (See reference 5 for details). In other words, the IFTE would have to be supplemented with these four items in order to provide capability equivalent to the EETF APE. It is also advisable to retain the EETF peculiar power station in order to provide adequate 400 Hz power for the EOB and the four previously mentioned items of APE. The EETF power station 400 Hz converter provides at least 12.5 Kilovolt Amperes (KVA) of power, whereas the IFTE 400 Hz source is capable of only 2.25 KVA. It is

recognized that the IFTE's use of reconfigurable virtual instrumentation (circuit cards) provides flexible capability, but the above needs cannot be met.

Impact: An analysis is conducted to determine the sensitivity of the LCC results to not retaining APE (see Section 4.3.6). This analysis shows that the impact of not retaining APE is insignificant. The ranking of alternatives is unaffected.

Issue #5 - Fielding costs for six EETF: As stated by OMMCS, "(The) fielding cost of six EETF's were not included in the analysis."

Findings: The transportation costs for delivery of the last six EETF's were originally reported as included in the contract and already expended. Based on further investigation, it was found that the transportation costs were not included in the contract, but are paid separately by the government on delivery. Initial spares and repair parts were also assumed to have already been procured early on in the EETF program. It is now understood that each EETF is fielded with an Essential Repair Parts Stockage List (ERPSL). The costs of these initial spares and repair parts were found to be included under sustainment, replenishment spares and repair parts. We also found that we had inadvertently included sunk costs in our original estimates of the sustainment costs per system year. Finally, an installation cost was found to be appropriate for when the EETF is delivered to the using AVIM.

Impacts: The cost of the initial provisioning of spares and repair parts is moved to the proper cost element under fielding cost. Other sunk costs are removed from the estimates of sustainment costs. Transportation and installation costs of $32.8K and $2.1K per system are included in the results under fielding costs.

Issue # , - Contractor vs. organic logistics support: As stated by OMMCS, "The contractor logistic support (CLS) cost is not included in the analysis. If organic support is to replace CLS, then the cost associated in developing organic support should be included."

Findings: Based on discussions with PM Apache, cost estimates for CLS were included in their inputs for depot maintenance costs under sustainment. The costs associated with Apache transitioning to organic support and replacing CLS, however, were not included. Accordingly, based on a CECOM briefing (see reference 28), organic support is expected to save approximately $685K per year over CLS. This organic support will be implemented in the near future at a one-time implementation cost of from $600K to $900K.

Impact: The costs and savings associated with Apache transioning to organic support are included.

Issue #7 - EETF training base: As stated by USATMDEA, "--- the cost of maintaining an additional training base for the low-density MOS operator of the EETF (should be included)." As stated by OMMCS, "Life cycle

costs associated with training and maintaining a system-specific MOS (39B) were not adequately addressed."

Findings: The cost impact of maintaining a separate training base for the EETF operator MOS was included in the original briefing, but it was claimed to be in error. Estimates for recurring costs for advanced individual student training were included as originally provided by OMMCS. These estimates, however, did not include an estimate of the overhead costs associated with the training for a system specific MOS. By request, these costs were identified and estimated (see reference 29). The costs per student week were increased from $1539 to $1748 for a 13 percent increase. This cost is reported to include direct costs for instruction, overhead, equipment depreciation, student pay and allowances, per diem, and travel; and indirect costs for base support, medical support, and family housing. An additional week of training was suggested for the EETF EOB bringing the total advanced training to 44 weeks. Additionally, OMMCS claims it will cost one man-year of effort each year for MOS proponency management. Other costs associated with the life cycle management of a system specific MOS, to include recruitment and sustainment of the MOS in the field, were noted but not provided. Regardless, the additional costs included in the $1748 per student week and the additional week of EOB training amount to an increase of approximately $6.0M over a 20 year life cycle, which is less then three percent.

Impact: The additional training costs are included in the LCC results, but the impact is determined to be insignificant. The relative cost comparison and ranking of alternatives are unaffected.

Issue #8 - Procurement mode - commercial catalog vs. Technical Data Package (TDP): As stated by USATMDEA, "Since update of the EETF would be dependent on procurement from commercial catalogs which reflect technical obsolescence every 7 to 8 years, and since IFTE is based on TDP procurement, it is likely that EETF would be more costly and difficult to update than IFTE."

Findings: Based on discussion with PM TMDE, this statement was an observation and could not be verified by data. AMSAA had previously conducted a Form, Fit and Function (FFF) Study to explore the impact of acquiring Class IX repair parts by using FFF specifications instead of detailed design specifications. It was found that commercial procurements (or FFF) for non-developmental items often increase competition, which in turn, lowers unit prices. Another AMSAA study, concerning the break-out of individual system components to provide to prime contractors as government furnished material, also concluded that significant savings are gained by competition. Therefore, it appears that if EETF is supported through commercial catalog procurement and IFTE through TDP procurement, the EETF would be the least costly to update.

Impact: If any, EETF would have the advantage through commercial procurements. Since the impact of various forms of procurement on costs are difficult to estimate, upgrading costs for EETF and IFTE are assumed to be equivalent. Therefore, this issue has no impact on the LCC results.

Issue #9 - Maintenance of an additional item in the inventory: As stated by USATMDEA, "--- the cost of maintenance of an additional item in the inventory must be included in a decision to continue the EETF."

Findings: Continuing to support EETF will indeed require the maintenance of an additional item in the inventory. However, there are currently about 145 Core-410's in the field. Not all the systems being supported are going to transition to IFTE. The extra cost for maintaining this item in the inventory will be accrued regardless of continuing to support EETF or transitioning to IFTE. Therefore, the extra cost cannot be attributed to Apache.

Impact: There will be an extra cost for maintaining an additional item in the inventory regardless of EETF. Therefore, this issue has no impact on the LCC results.

6.4 Other Issues.

Issue #1 - Time-frame for analysis: As stated by USATMDEA, "--- the time-frame on which the life cycle cost and decision is based in this analysis (FY92 - FY11) is incorrect. --- If a 20-year life cycle is assumed, a more logical time-frame on which to base the EETF/IFTE decision is FY98 - FY17." The age difference between EETF and IFTE is mentioned as the reason for this concern. As stated by OMMCS, "(The) IFTE 20-year sustainment cost (is) contaminated with 6 years of EETF sustainment cost. --- Shifting the comparison point out 5 years will eliminate this problem ---".

Findings: The objective of any cost/benefit study is to compare alternative systems or options in order to determine the optimum use of resources for the maximum realization of benefits and to determine immediate budget needs. The period for comparison, according to AR 11-28 (reference 22), should commence with the earliest year in which initial expenditures are made for any of the alternatives. The period ends with the alternative with the longest economic life or the end of service life. According to PM Apache, the Apache may be ready to go to a two level maintenance structure at the end of EETF use and will no longer have a need for ATE. The proper period for comparison, therefore, is from the current date (since EETF is already in service) to that date when the ATE is no longer needed (around 2011). The most important point is to compare alternatives over the same time-frame. Furthermore, if the decision is made to transition to IFTE, the EETF will be used in the interim until IFTE can be fielded. Regardless, an analysis is conducted to show the sensitivity of LCC results to the immediate fielding of IFTE, which eliminates the penalty of a late fielding (see Section 4.3.1 for details). Sensitivity analyses are also conducted to determine the impact of IFTE having a residual value after Apache use and to the total time-frame for analysis (10, 15, 20 or 25 years - see Sections 4.3.7 and 4.3.3 respectively). In all cases, the ranking of alternatives is unaffected.

Impact: The time-frame for analysis was determined to be correct. Regardless, the sensitivity of LCC results to immediate fielding, IFTE having a residual value, or to the overall time-frame for analysis shows that the ranking of alternatives is unaffected by the assumptions made concerning these variables.

Issue #2 - Age difference between EETF and IFTE: As stated by USATMDEA, "At the beginning of FY98, IFTE will be new, ECP185(R)2 will be 6 years old, and the 'rack and stack' part of EETF will be 13 years old."

Findings: As stated earlier, the IFTE ATE is of 1980's vintage technology and the ECP185 upgrades the EETF computer control and display subsystems to 1980's technology. The remaining portion of the Core-410 is of 1960's technology and a cost should be included for updating that equipment.

Impact: The costs of the recurring sustaining engineering effort provided by GE for the remaining Core-410 equipment are included in the LCC results. See the discussion of cost issue #3 for further details on the costs of recurring sustaining engineering efforts.

Issue #3 - Benefit Analyses: As stated by OMMCS, "(The) Study made no attempt to quantify (the) value of standardizing ATE ---, multi-system/multicommodity support, improved electro-optic (EO) capability, personnel reduction made possible by consolidation, or improvements in battlefield utilization."

Findings: Originally, potential benefits were not addressed because of the lack of data from which to measure the impact. All one could do was provide an outline of the benefits achieved and a qualitative assessment. Furthermore, we were not aware that the IFTE provided improved EO capability. Clarification of this point is that the EO testing capability will be expanded from the experience gained by having many more IFTE's fielded than EETF to support many other systems. The only personnel reduction we were aware of was through the use of the generic electronic maintenance concept and the sharing of IFTE with many systems. Finally, due to the space requirements for the support of Apache and the probable use of the EETF vans to house IFTE, it is doubtful that IFTE will significantly improve battlefield utilization for Apache. Regardless, the IFTE does have a number of benefits which are outlined and assessed in Section 5. The advantages and disadvantages of the various options are included in that assessment.

Impact: The benefits of IFTE vs. EETF are outlined and addressed in section 5. The data required to measure benefits are still lacking.

6.5 Summary.

Many of the issues raised that directly impact on costs are valid. The LCC comparison of alternatives is revised accordingly and the results are shown in section 4.1. The impact of the revised costs and above adjustments on the LCC comparison are presented in Table 26. As shown, although relative costs have changed to some degree, the ranking of alternatives is unaffected.

Table 26. LIFE CYCLE COST ADJUSTMENTS.

Costs	Costs (FY91 Constant $M)				
	EETF w/ ECP185R2	IFTE w/ EETF EOB	IFTE w/ New EOB	IFTE w/ Dual Stn	IFTE w/ No EOB
Development	0.0	18.3	22.5	42.5	18.3
Production	0.0	92.0	166.4	175.7	92.0
Fielding	0.4	3.7	6.4	6.4	3.7
Sustainment	227.5	195.9	162.5	178.9	155.4
SRA Costs					81.0
Draft Study Results	227.9	309.9	357.8	403.5	350.4
Revised Study Results	232.9	325.3	342.0	387.1	334.9

Issues raised on the wartime support are valid. To date, however, the Army has not supported procurement of ATE to support the wartime requirements for Apache. Clearly, if a decision is made to procure ATE to the wartime requirement, then IFTE becomes the preferred system.

Issues raised concerning the support of Apache through a generic electronic maintenance company were considered. According to the developer of the generic maintenance concept (OMMCS), Apache is specifically excluded from this support. The current Army policy is to support Apache with dedicated ATE at the AVIM level. Apache usage of ATE would have to be less that 40 percent of the total workload capacity to make IFTE competitive with EETF. Since the Apache is anticipated to require 70 percent of the available capacity, taking the sharing of excess capacity into account does not change the conclusions.

Overall, taking the issues raised into account has changed some of the cost benefit comparisons, but the conclusions reached are still valid for the peacetime support of Apache. Continued support of the Apache fleet with the EETF is the least cost alternative.

7. FINDINGS, CONCLUSIONS AND RECOMMENDATION

The findings of this study are based on a thorough cost analysis and comparison of the current EETF configuration with implementation of ECP185(R)2 to various alternatives of transitioning to IFTE. Subjective assessments of their benefits are also made. The following summarizes our findings:

The life cycle costs for EETF with the ECP are significantly less than IFTE. While the sustainment costs for IFTE are less than EETF, the savings do not offset the acquisition costs for IFTE.

Analyses are also conducted to determine the sensitivity of results to various assumptions and issues. The ranking of alternatives is unaffected by assumptions concerning fielding schedules, life cycle period, peacetime quantity requirements, dedicated vs. shared ATE support, replacement of the nontactical floor mounted EETF's, retention of APE and inflation and discounting. In every case, the results show that the current support option, retaining the EETF with the ECP185(R)2 upgrade, is the least costly alternative. The most costly alternative, in all cases, is IFTE with a dual work station. The ranking of the other three IFTE alternatives fluctuate from case to case. The consideration of retaining the current EETF EOB to use with IFTE is predominantly the lowest cost IFTE alternative. Sensitivity analyses comparing the costs of buying ATE in sufficient quantities to meet wartime requirements, however, show IFTE being competitive or even less costly than EETF. Of the configurations considered for housing the IFTE, configuration A, two EETF vans, is the least costly configuration in all except the "residual value" and "buying to wartime" cases. However, the difference in costs for the configurations considered is only about $8.2 million. In any case, the ranking of alternatives is not sensitive to any of the assumptions considered except for buying to wartime instead of peacetime requirements. In this case, IFTE is the least cost alternative.

Transitioning to IFTE is feasible and there are many benefits and advantages for doing so. IFTE with the S-280 shelter provides multi-system support, better transportability, NBC protection, technological advancements and enhanced user friendliness. However, there is also limited space in the S-280 shelter for the EOB, APE, and the TPS's and ICD's needed for Apache. Disruption of the current AVIM ATE support structure caused by pulling EETF's out of the field in order to install the IFTE BSTS into the vans would be a major disadvantage. Considering this and the required additional investment of $102M to $206M to acquire IFTE for Apache, the disadvantages of IFTE outweigh the advantages.

In conclusion, the EETF with the ECP185(R)2 upgrade is the least cost approach for the peacetime support of Apache and based on contractor statements, the upgraded computer is supportable through FY2010. If, however, Army policy is ever changed to buy ATE to wartime requirements, then IFTE is the preferred alternative.

At this time, it is recommended that the Army continue to use the EETF to support Apache. If, however, another ECP of the magnitude of ECP185(R)2 or another buy of EETF's is ever required in order to have EETF remain in the field, then transitioning to IFTE should be reconsidered. It is also recommended that the planning and budgeting for transitioning to IFTE be initiated.

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22. AR 11-18, "Army Programs - The Cost and Economic Analysis Program", dated 7 May 1990, Headquarters, Department of the Army, Washington, DC.

23. Memorandum, from Deputy Executive Director for TMDE, HQ AMC (AMCTM), dated 8 August 1991, Subject: "Cost/Benefit Analysis of AH-64 Apache Automated Test Equipment (ATE)".

24. Memorandum, from OMMCS (ATSK-CCT), dated 15 August 1991, Subject: "Cost Benefit Analysis of the AH-64 Apache Automatic Test Equipment".

25. Letter, from CASCOM (ATCL), dated 13 September 1991, no subject.

26. Memorandum, from AMSAA (AMXSY-LR), dated 10 October 1991, Subject: "Cost/ Benefit Analysis of the Apache Automated Test Equipment".

27. Letter, from AMSAA (AMXSY-L), dated 10 October 1991, no subject.

28. Briefing, by CECOM Systems Management Directorate, dated 11 June 1991, Subject: "Contractor to Organic Field Support Transition Plan for AN/USM-410A(V)4 and AH Peculiar EETF Subsystems".

APPENDIX A

ELECTRONIC EQUIPMENT TEST FACILITY (EETF) AND ENGINEERING CHANGE PROPOSAL (ECP)185(R)2

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APPENDIX A

ELECTRONIC EQUIPMENT TEST FACILITY (EETF) AND ENGINEERING CHANGE PROPOSAL (ECP)185(R)2

In this appendix, the configuration of the current EETF and the changes made as a result of ECP185 are pictured. As shown in Figure A-1, the current EETF test van is comprised of the AN/USM-410 computer, several racks of Apache Peculiar Equipment (APE), and a large Electro-Optics Bench (EOB). The test van also houses the power stations and air conditioning unit. This van is expandable on both sides. All the Automatic Test Equipment (ATE) is located in the center of the van with a walkway/work space provided around the inside perimeter of the van. A second storage van is connected to the test van which houses all of the Test Program Sets (TPS's) and Inter-Connecting Devices (ICD's) and supplies. The power for both vans is provided by two generators.

Figure A-2 shows the components that comprise the AN-USM Core-410 computer and APE (excludes the EOB). As shown, the ECP185 will replace the computer, display and control substations with newer equipment. The Core-410 computer is comprised of 1960's technology whereas the ECP185 upgrade is comprised of 1980's vintage technology. Remaining Core-410 hardware will still be comprised of 1960's technology, but will be upgraded at the component level as a recurring engineering effort.

Figure A-3 shows the EOB and the electronics station required for power conversion. Figure A-4 shows a picture of the interior of the EETF storage van while Figure A-5 shows a picture of the TPS hardware that is stored in the support van.

As shown in Figure A-6, ECP185(R)2 replaces the obsolescent AN/USM-410 computer, control and display subsystems. The hardware items being replaced are comprised of the computer, tape drive, disk drive, and video display terminal. Currently, the subsystem occupies two racks of equipment. Through the ECP, the upgraded system occupies only one rack of equipment.

Apache EETF Configuration

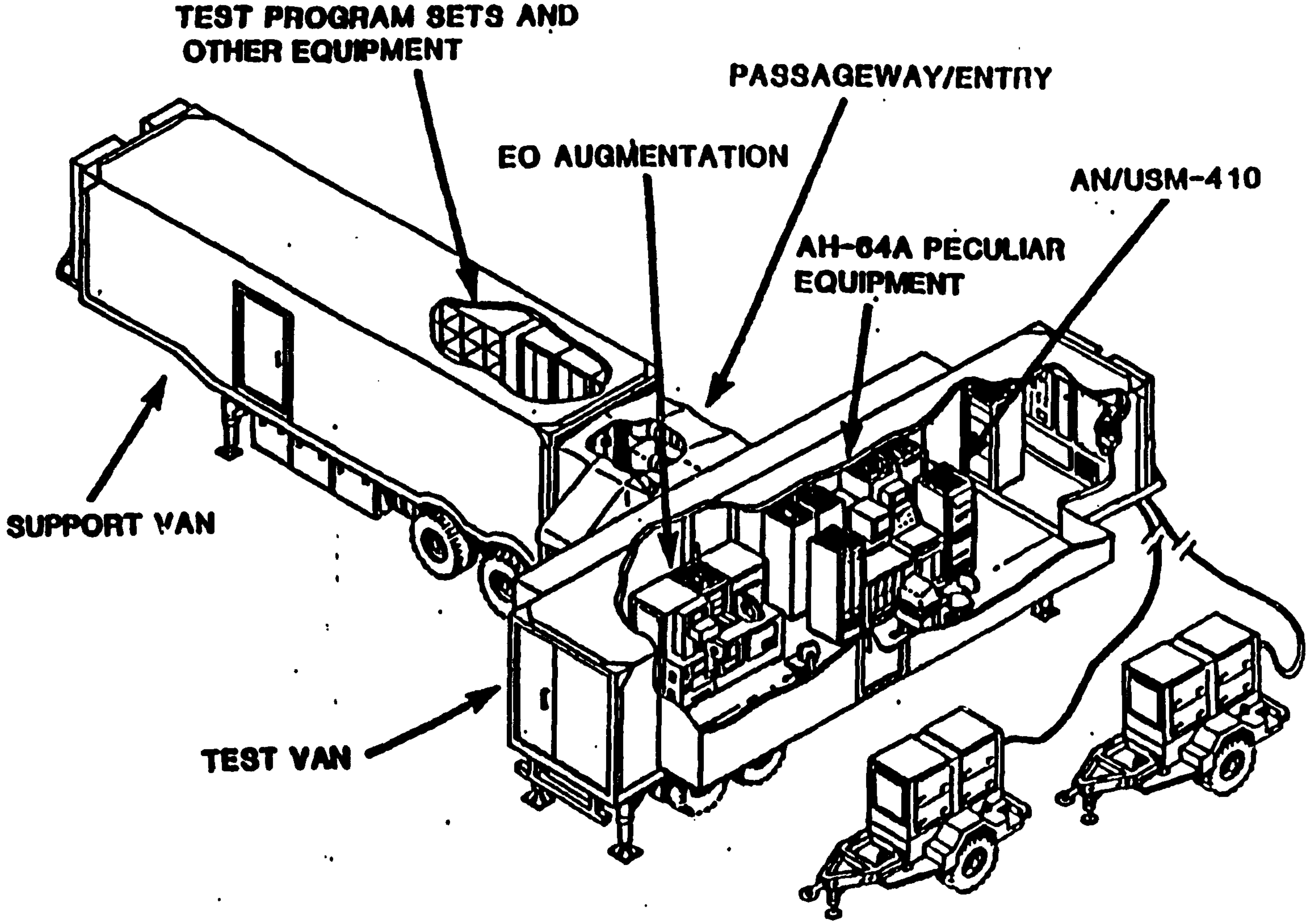

Figure A-1. Apache EETF Configuration.

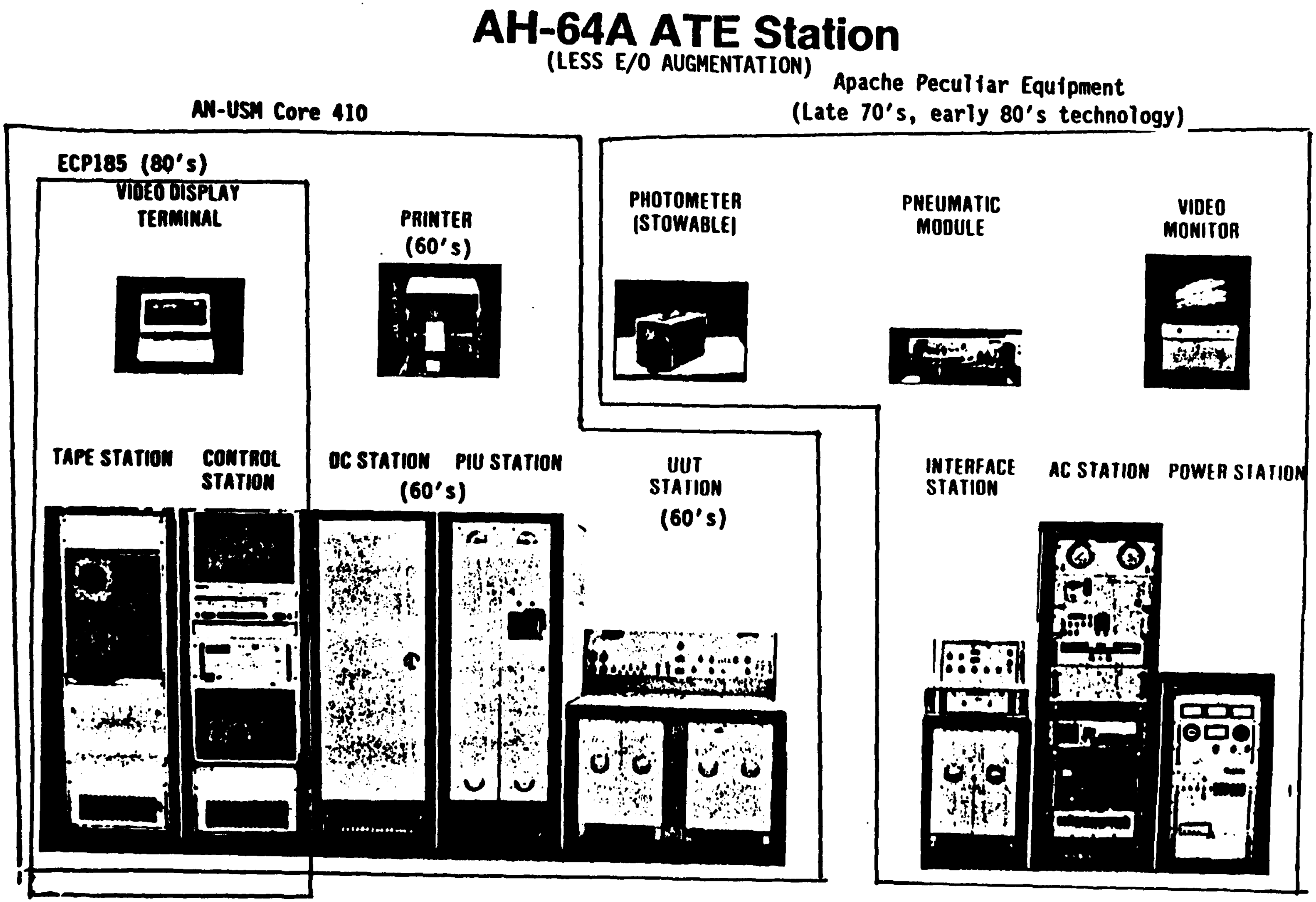

Figure A-2. Apache ATE Components (Excluding EOB).

ELECTRONIC EQUIPMENT TEST FACILITY
ELECTRO/OPTICAL AUGMENTATION

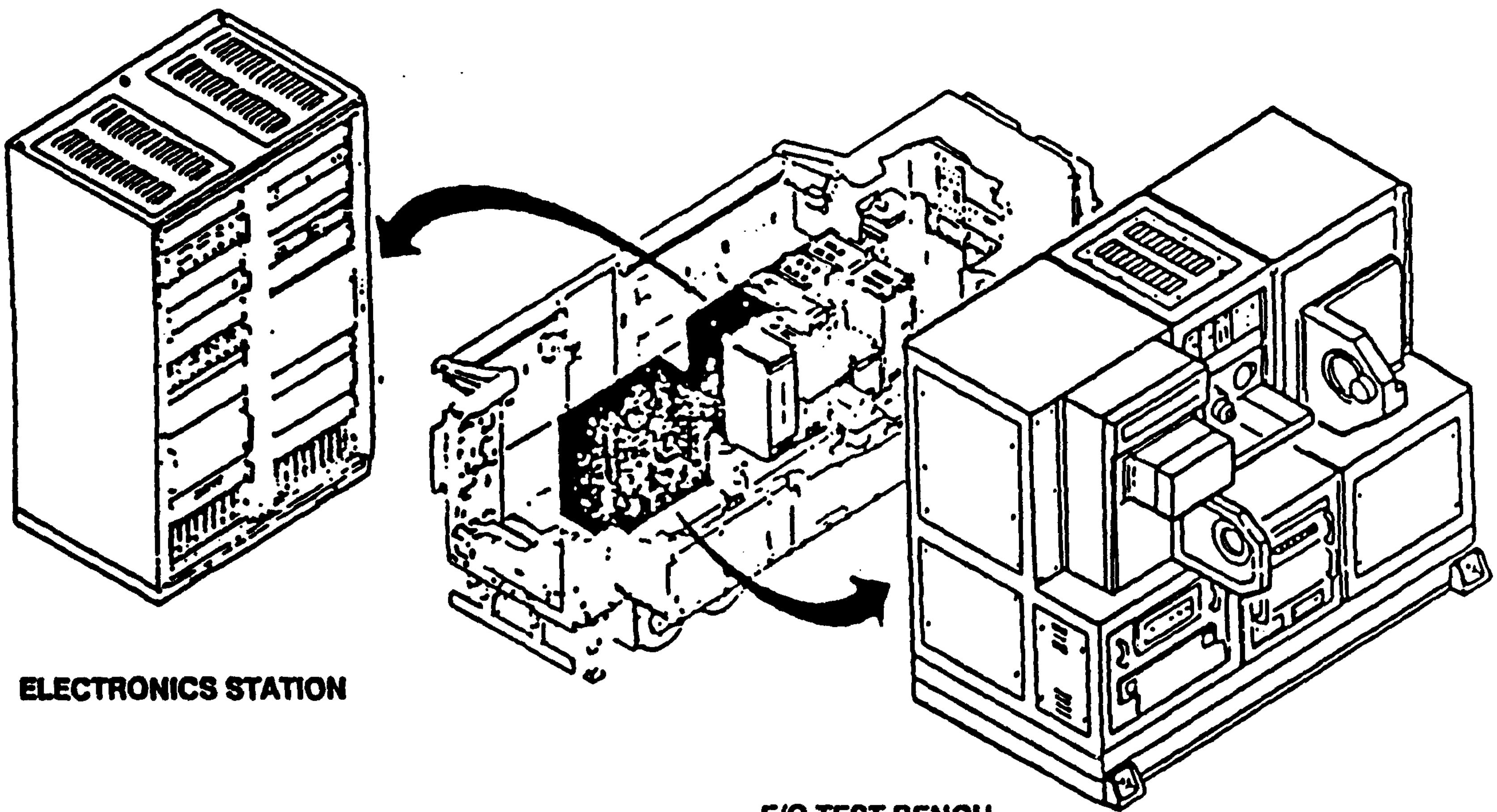

Figure A-3. Apache EETF Electro-Optical Augmentation.

Figure A-4. EETF Storage Van (Interior).

TPS Hardware

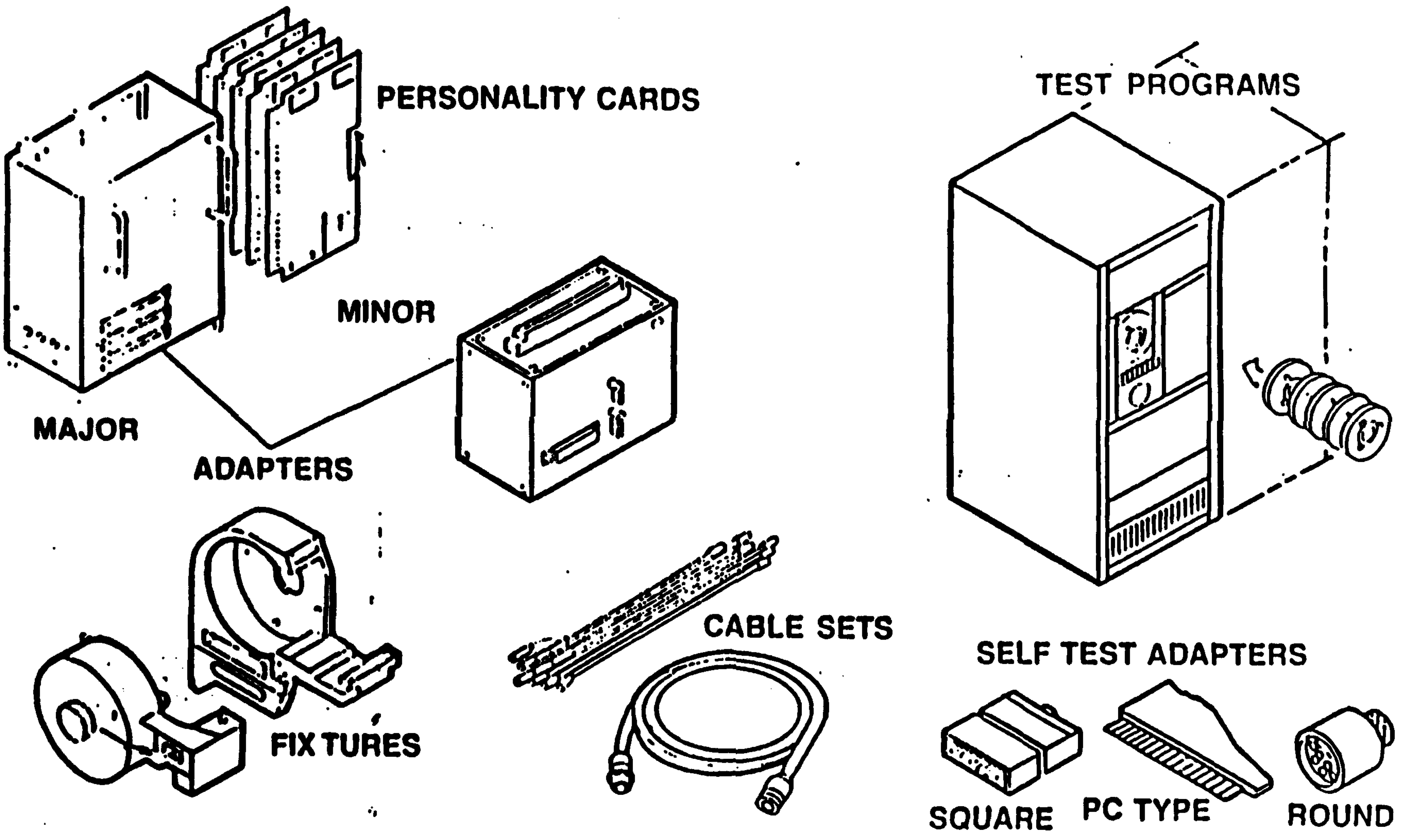

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Figure A-5. TPS/ICD Hardware.

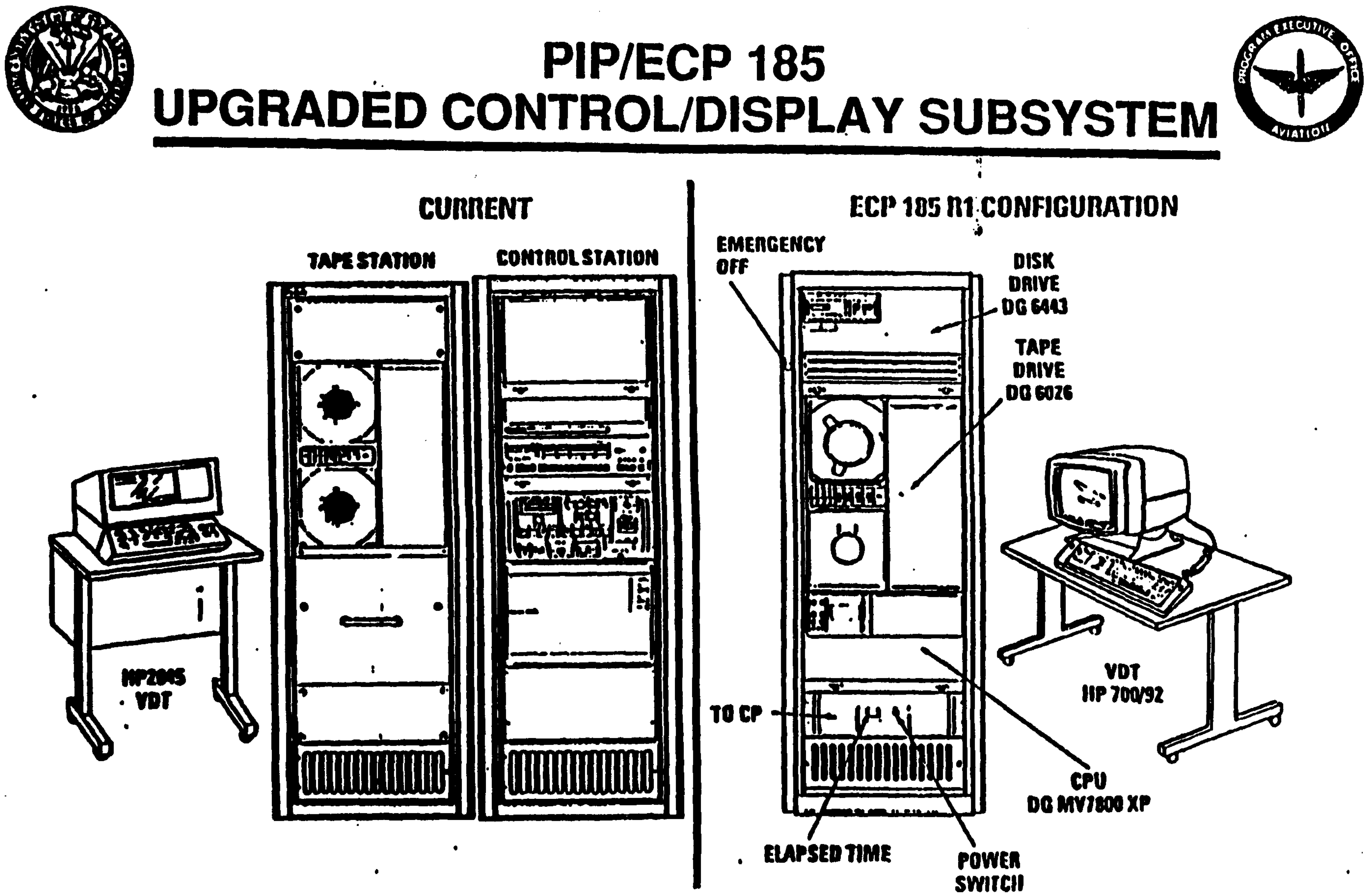

Figure A-6. ECP185(R)2 Upgraded Computer Control and Display Subsystems.

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APPENDIX B

STANDARD INTEGRATED FAMILY OF TEST EQUIPMENT (IFTE) AND OPTIONAL CONFIGURATIONS

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APPENDIX B

STANDARD INTEGRATED FAMILY OF TEST EQUIPMENT (IFTE) AND OPTIONAL CONFIGURATIONS

In this appendix, the standard IFTE configuration and an optional configuration for replacing the single work station with a dual work station are pictured. As shown in Figure B-1, the standard IFTE Base Shop Test Facility (BSTF) is to be housed in an S-280 shelter mounted on the back of a five ton truck. The Test Program Sets (TPS's), Inter-Connecting Devices (ICD's), and other supplies are housed in a separate S-280 shelter. Both shelters are electrically powered by a separate power generator.

Figure B-2 shows a picture of the interior of the IFTE Base Shop Test Station (BSTS). As shown, the test station, the computer and Automatic Test Equipment (ATE) hardware are all located on the roadside of the van. As shown in Figure B-3, the curbside of the basic IFTE BSTF has a desk assembly with storage space for additional equipment and a power distribution center. Figure B-4 shows an artist's rendition of where the new EOB will fit into the IFTE BSTF.

Figures B-5 and B-6 show an artists rendition of an IFTE BSTF with two work stations. Figure B-5 shows the roadside of the interior while Figure B-6 shows the curbside. This option was originally developed a few years ago. A prototype was produced and tested, but the single work station concept was adopted and the dual work station concept was terminated.

Due to the limited space available in the basic IFTE BSTF for worker maneuverability and to the size of the Apache Line Replaceable Units for test, it is our opinion that this configuration is incompatible for the support of Apache. Instead, several different options for housing the IFTE BSTF and TPS's/ICD's are suggested as follows:

(a) Either remove the ATE hardware from the current Electronic Equipment Test Facility (EETF) vans and replace it with the IFTE hardware,

(b) Place the new EOB and the Apache Peculiar Equipment (APE) that must be retained from the EETF in a separate S-280 shelter and house the TPS's/ICD's in two separate shelters so as to require four shelters in all, or

(c) Use some combination of the current vans and the S-280 shelters to house the IFTE BSTF and TPS's/ICD's in support of Apache.

TPS's/ICD's are developed by contractors and special equipment configurations are available for IFTE to support these contractors. First, an Army TPS Support Environment (ATSE) work station, as shown in Figure B-7, is available for actually developing or converting the TPS's. Once developed, hardware similar to the full-up tactical BSTF is required to test the TPS's/ICD's against the actual LRU's for tests. Such equipment, called Commercial Equivalent Equipment (CEE), is available for IFTE as shown in Figure B-8. This equipment is floor mounted but provides the same functions as the ATE in the IFTE BSTF.

As shown above and represented in Figure B-9, the IFTE provides a total maintenance system. The Contact Test Set (CTS), an integral part of the IFTE program, is not required for the support of Apache.

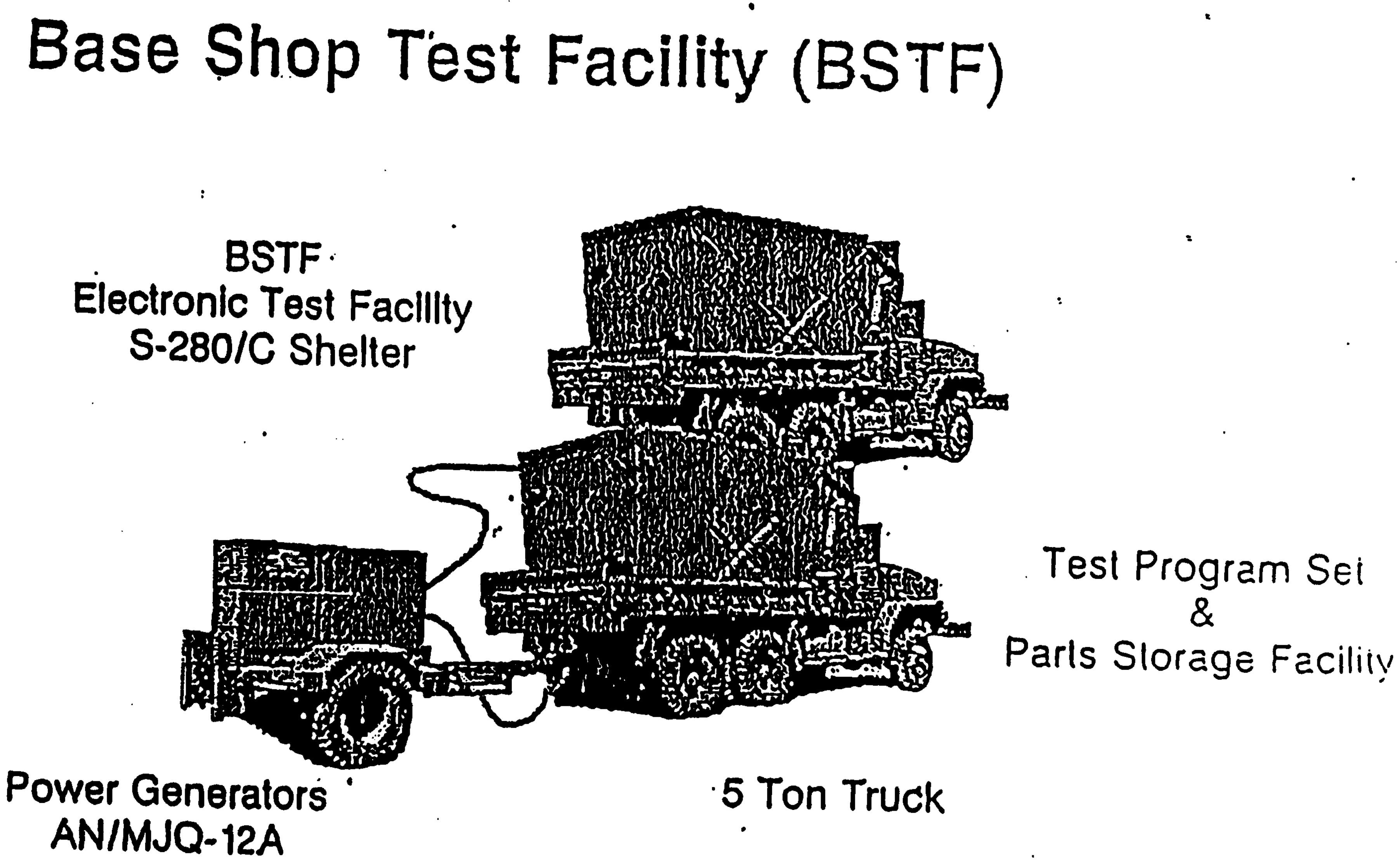

Figure B-1. IFTE BSTF.

IFTE
Base Shop Test Station

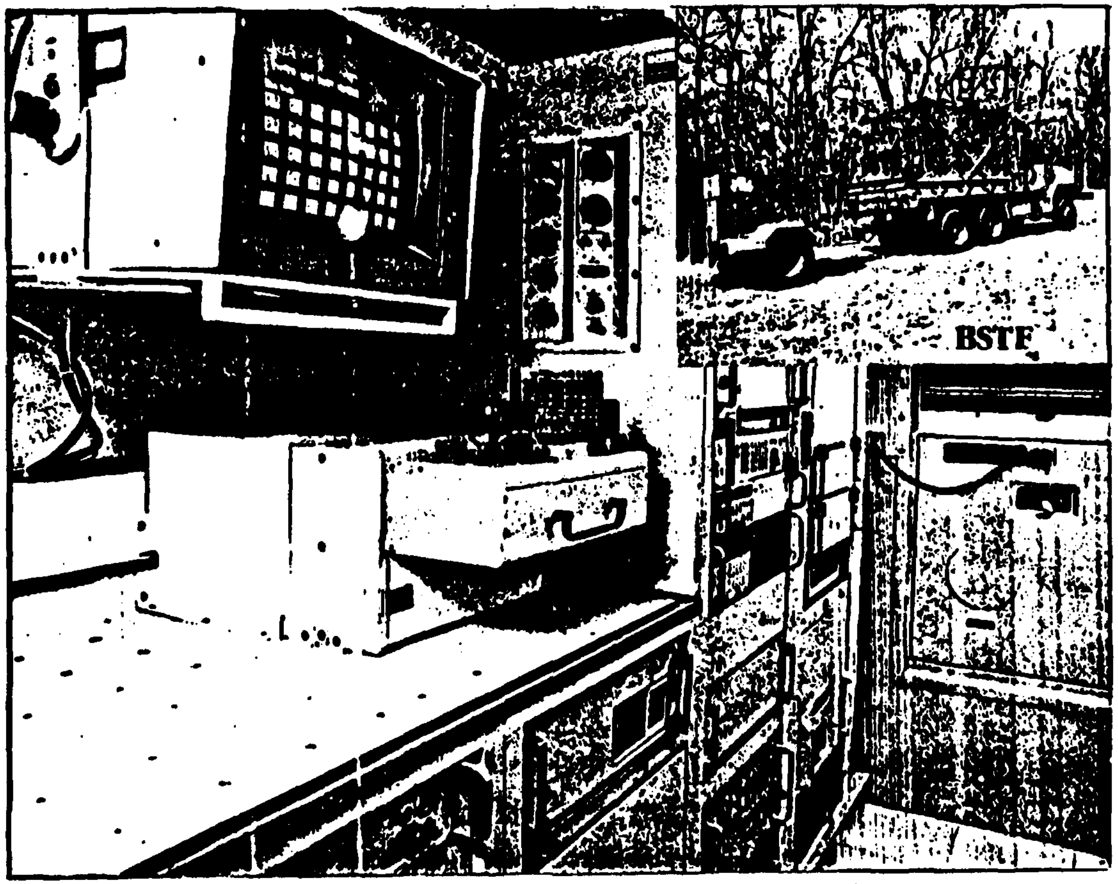

Figure B-2. IFTE BSTF (Interior - Roadside).

BSTS (CURBSIDE)

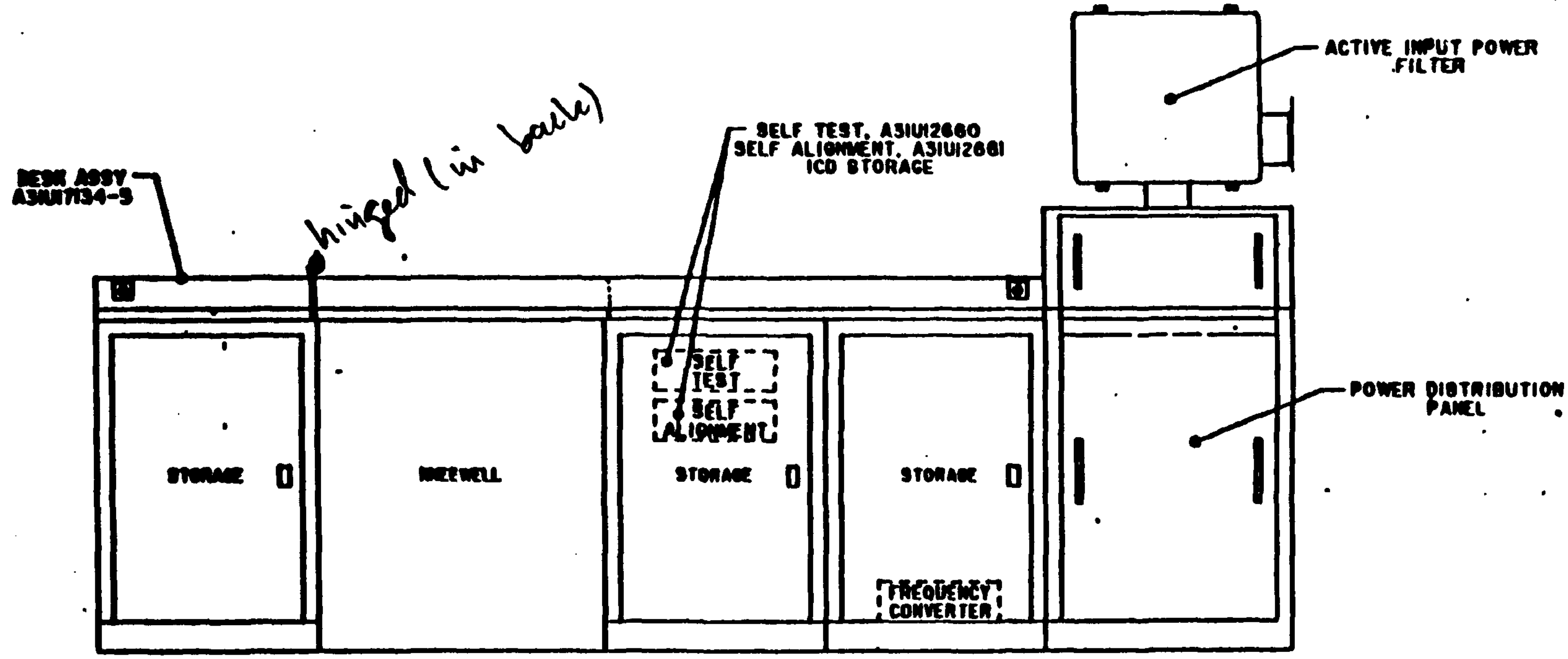

Figure B-3. IFTE BSTF (Interior - Curbside).

ATP.IFTE.ELEVATION.BSTS CURBSIDE

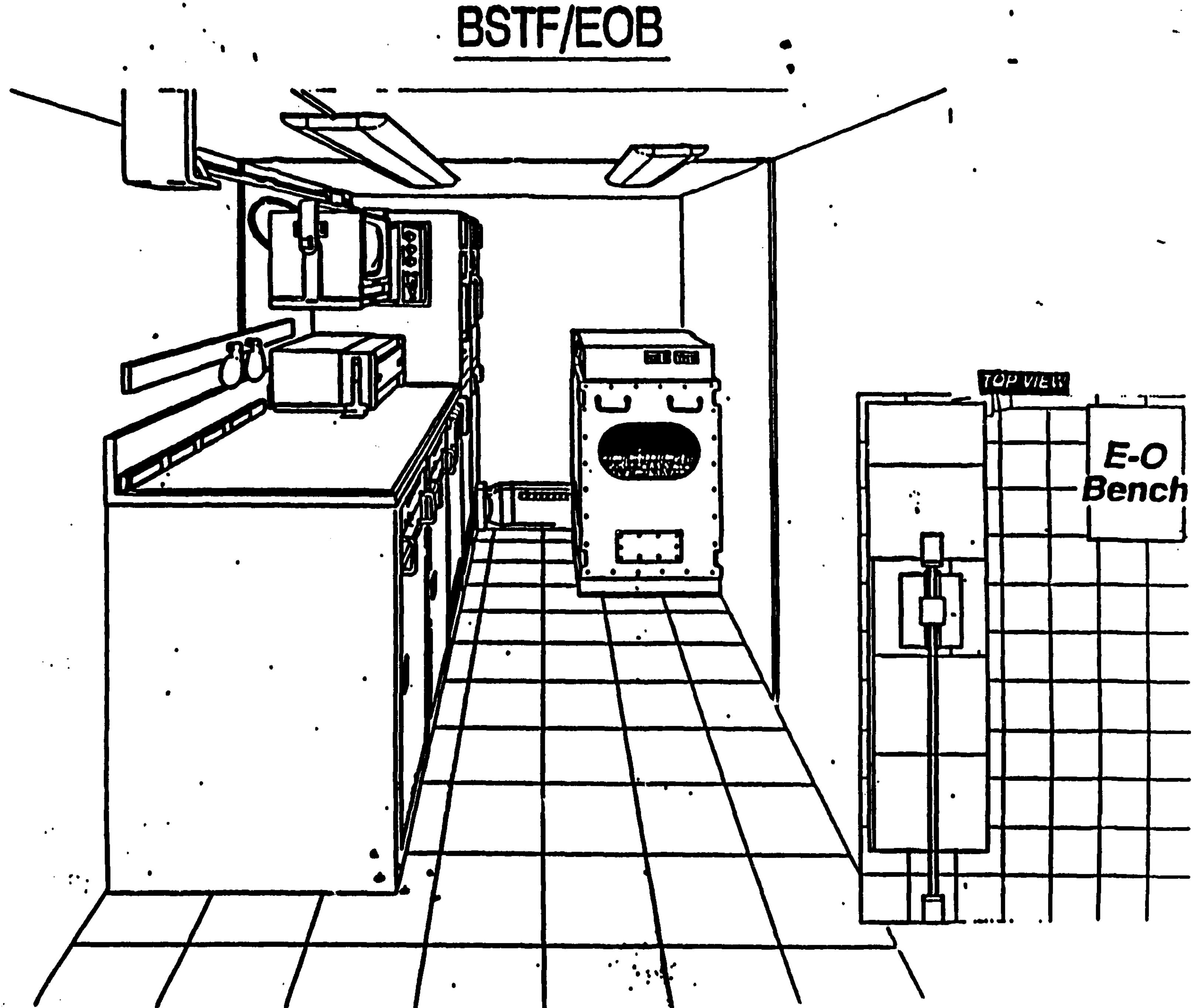

Figure B-4. Basic IFTE Configuration with New EOB.

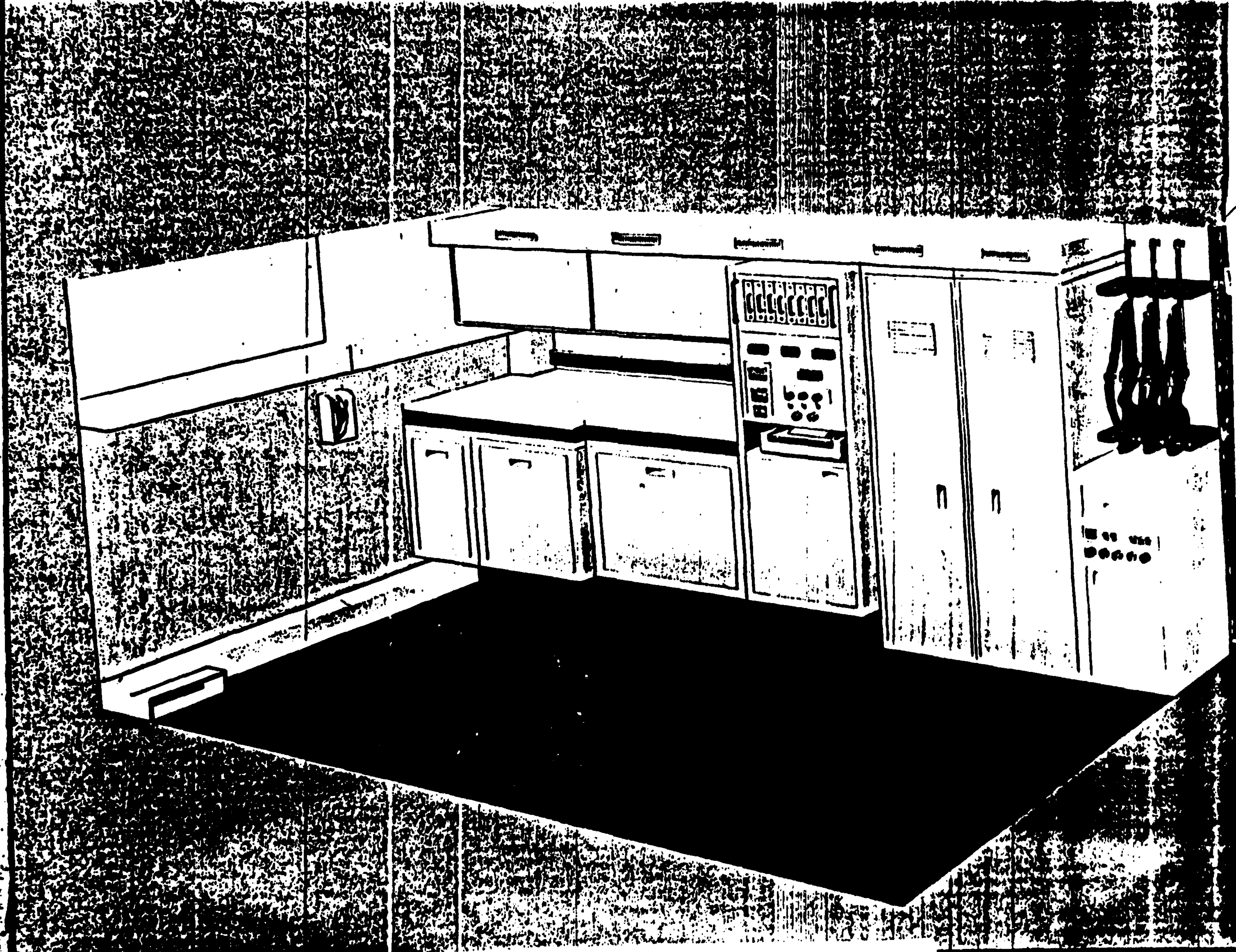

Figure B-6. IFTE BSTF with Dual Work Station (Curbside).

Army Test Program Set Support Environment (ATSE) Workstation

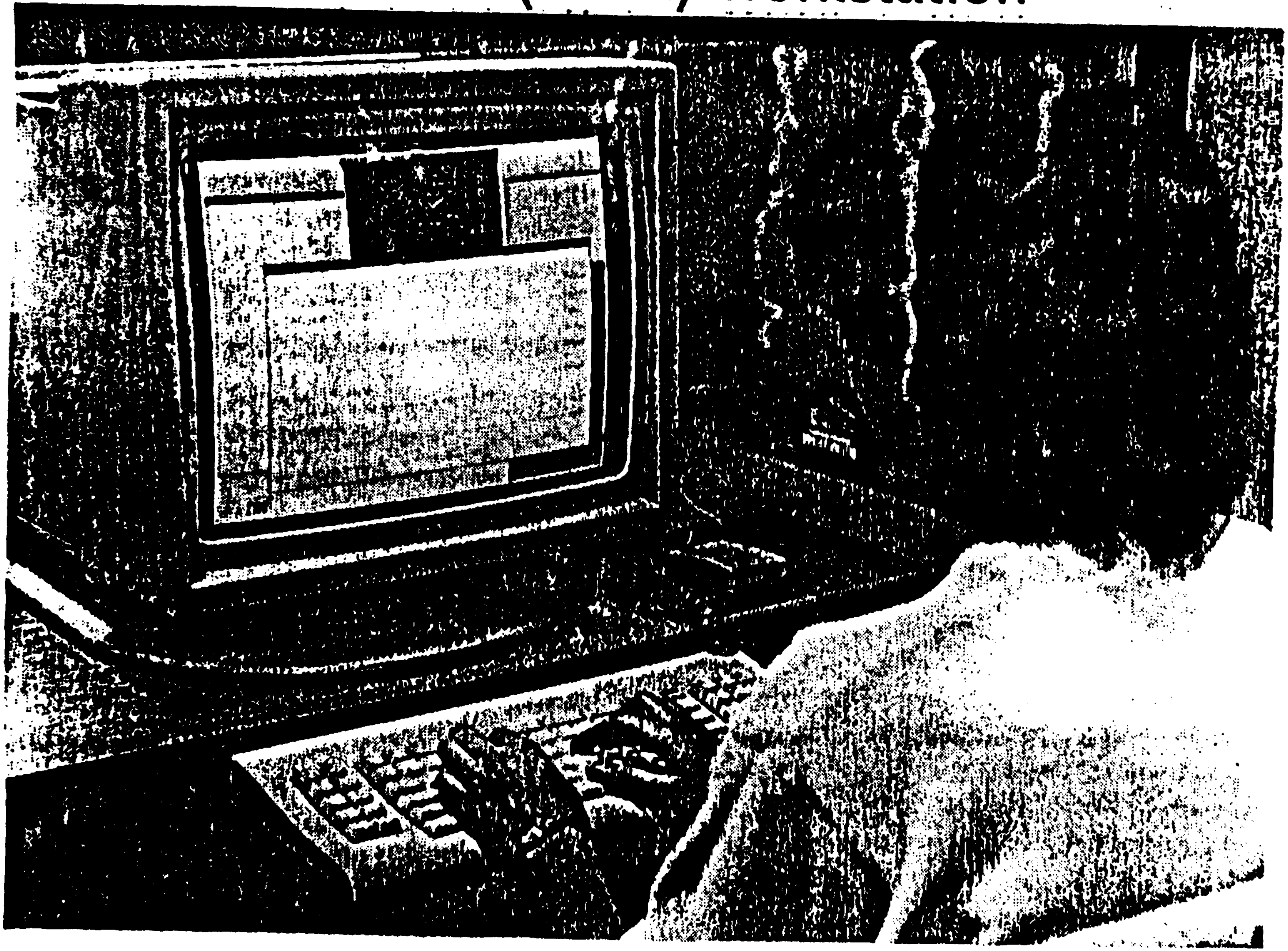

Figure B-7. ATSE Work Station.

Commercial Equivalent Equipment (CEE)

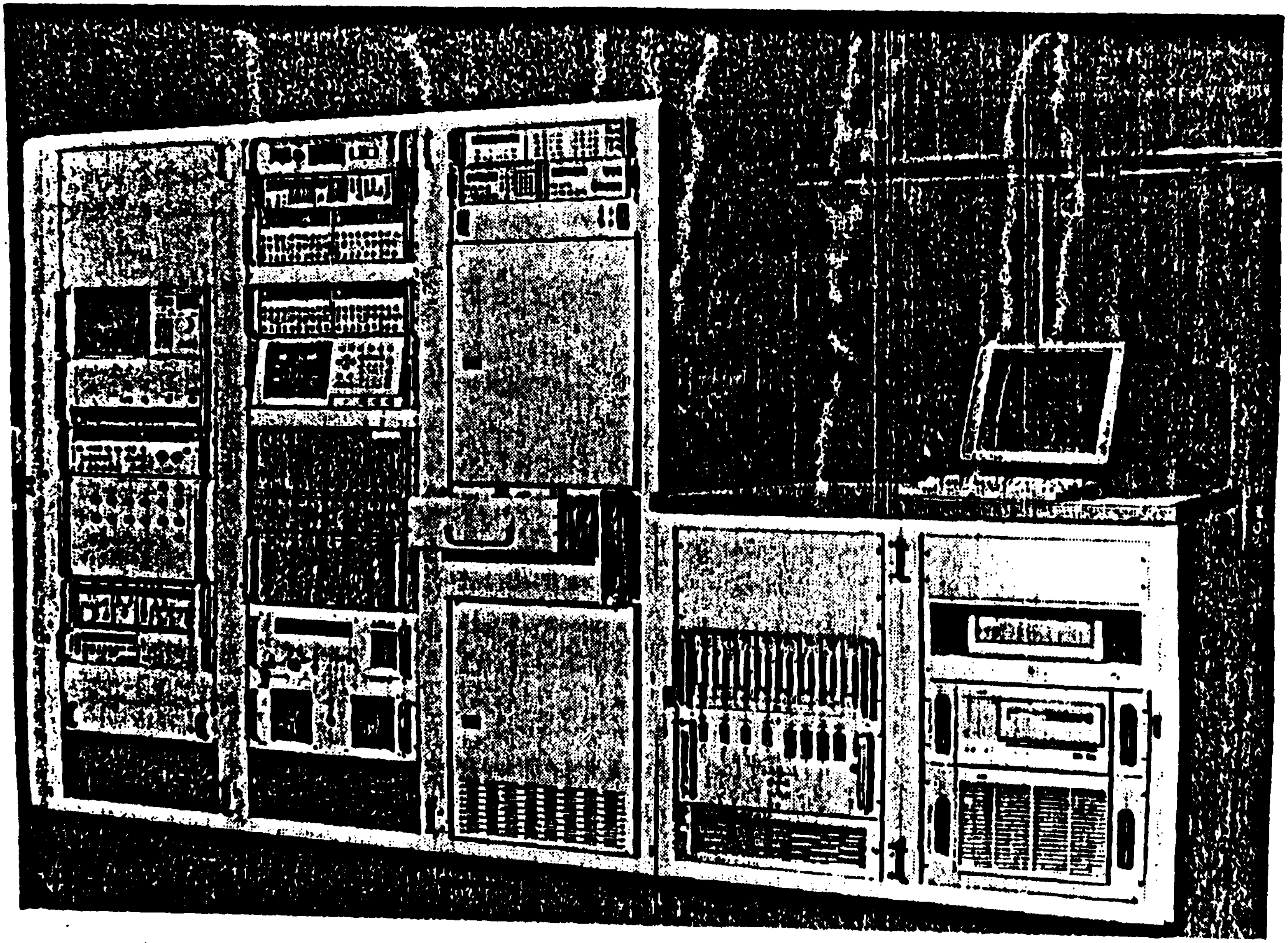

Figure B-8. IFTE CEE.

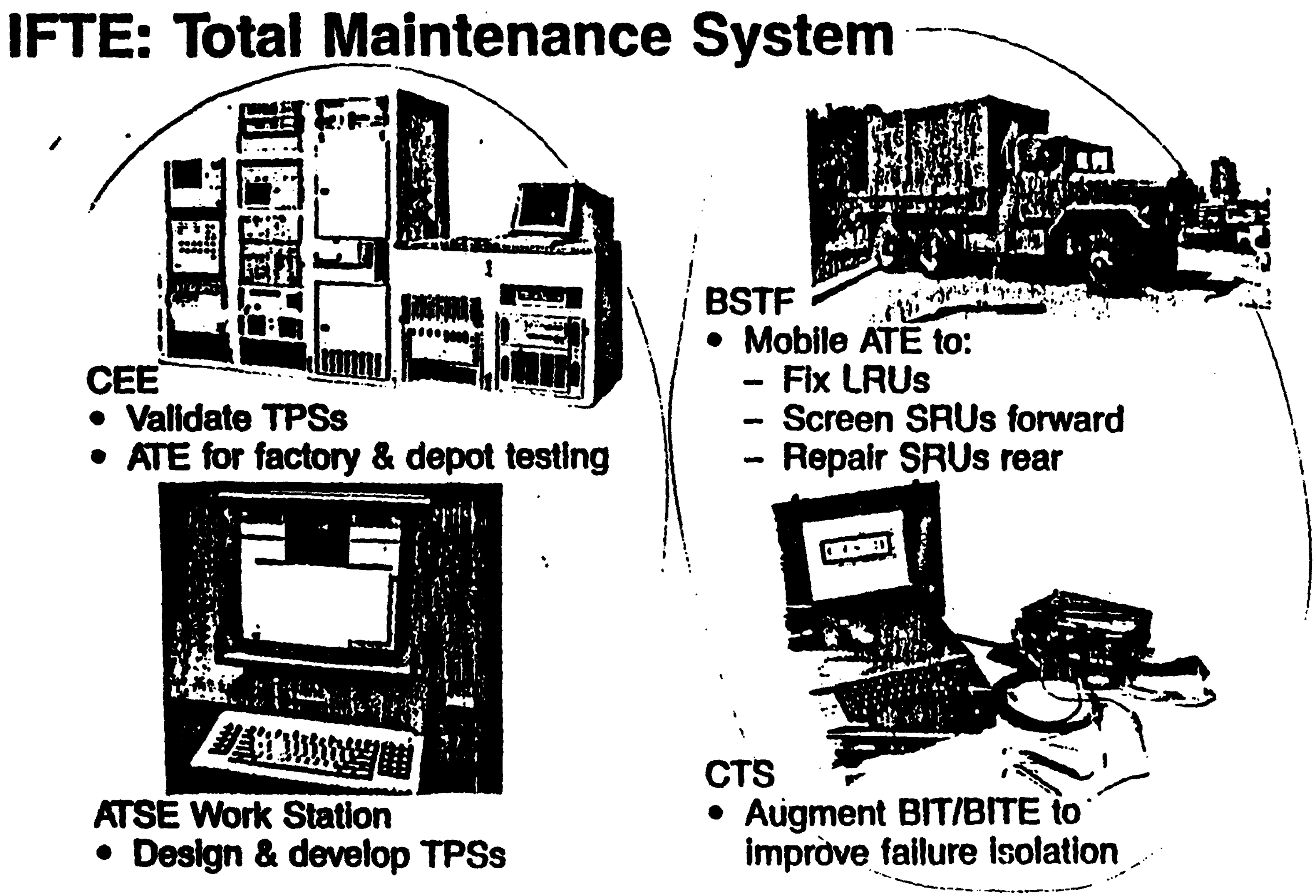

Figure B-9. IFTE - the Total Electronics Maintenance System.

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AMXSY-LR

STUDY GIST

SUBJECT: Technical Report #519, "Cost/Benefit Analysis of the AH-64 (Apache) Helicopter Automated Test Equipment (ATE)".

PRINCIPAL FINDINGS: The Life Cycle Costs (LCC) for the Electronic Equipment Test Facility (EETF) with the ECP185(R)2 computer upgrade are significantly less than the Integrated Family of Test Equipment (IFTE). Moreover, the ranking of alternatives is unaffected by assumptions concerning fielding schedules, life cycle period, peacetime quantity requirements, dedicated vs. shared ATE support, replacement of floor-mounted EETF's, retention of Apache Peculiar Equipment (APE) and inflation and discounting. In every case, retaining the EETF with the ECP is the least cost approach for the peacetime support of Apache. Sensitivity analyses comparing the costs of buying ATE in sufficient quantities to meet wartime requirements, however, show IFTE being competitive or even less costly than EETF. Therefore, if Army policy were ever changed to buy ATE to wartime requirements, then IFTE would be the preferred alternative. Transitioning to IFTE is feasible and, with the S-280 shelter, it provides multi-system support, better transportability, Nuclear Biological and Chemical (NBC) protection, technological advancements and enhanced user friendliness. However, the S-280 has inadequate space for all the equipment, software, hardware and the crew. On the other hand, disruption of the current maintenance support structure caused by pulling EETFs out of the field in order to install the IFTE into the EETF vans would be a major disadvantage.

MAIN ASSUMPTIONS: Assumptions made for conduct of the study are:

a. The ATE used to support Apache will be used at the Aviation Intermediate Maintenance (AVIM) level and will be dedicated solely to the support of Apache.

b. The current Apache support structure and deployment of EETF units require a one-for-one replacement of tactical EETF's with IFTE. Nine of the 14 floor-mounted non-tactical EETF's will be replaced with dedicated IFTE assets.

c. IFTE will be fielded, in support of Apache, beginning in FY98.

d. The useful life of the EETF, with incorporation of the ECP upgrade, is 20 years. The useful life of IFTE is also 20 years.

e. The EETF Electro-Optics Bench (EOB) is not compatible with the IFTE computer. In order to retain the EETF EOB for use with IFTE, either a separate computer will be required, such as the upgraded Core-410 computer, or a major engineering and redesign effort will be required to reconfigure/integrate the EOB with the IFTE computer.

f. The IFTE currently does not have all the required APE capabilities and some of the APE must be retained if Apache transitions to IFTE.

PRINCIPAL LIMITATIONS: The S-280 shelter, which is currently used to house the basic IFTE Base Shop Test Station, has inadequate space to also house the EOB and the retained APE. Either the current EETF van or a separate shelter will be required to house the EOB and APE. In addition, either the current EETF storage van or two S-280 shelters will be required to store all the Test Program Sets (TPS's) and Inter-connecting Devices (ICD's).

SCOPE OF THE EFFORT: The study focuses on the 36 EETF's that the Army has procured for the support of Apache. Twenty-two of these EETF's are in a tactical configuration and 14 are in a special purpose floor-mounted configuration. Several alternatives are considered for replacing the current EETF with IFTE. Alternatives range from retaining the old EETF EOB to incorporating a new EOB developed by the Navy to eliminating the EOB altogether and sending all electro-optic components directly to a special repair activity for depot level repair. A dual work station capability is also considered.

BJECTIVE: The objective of the analysis is to compare the costs, benefits and easibility of retaining the EETF with the ECP185(R)2 computer upgrade versus arious options available for transitioning to IFTE for the support of Apache.

ASIC APPROACH: A cost/benefit analysis is conducted to evaluate the ATE equirements and alternative options available to provide fault location/ etection capability for electronic components for the support of the Apache elicopter. First, a LCC comparison of alternatives is conducted. Five alter- atives, to include the status quo and the different options available for ielding IFTE, and four shelter configurations for IFTE are considered. Quan- ity requirements for ATE are determined based on expected workload, ATE erformance capacity, operating schedule, and the maintenance structure and eployment of ATE to support the Apache. The LCC's, consisting of development, roduction, fielding and sustainment, are derived for each of the alternatives nd configurations. All alternatives are compared over the same 20 year time rame (FY92 through FY11). Since the IFTE is not expected to be fielded for pache until FY98, the EETF is treated as an interim system and associated osts are attributed to all IFTE alternatives. Various sensitivity analyses re conducted to determine the sensitivity of results to various assumptions. inally, a subjective assessment of the benefits of transitioning to IFTE and he advantages and disadvantages of each of the alternatives is provided.

EASON FOR PERFORMING THE STUDY OR ANALYSIS: A dedicated EETF has been and is urrently being used to provide fault detection capability for electronic omponents for the support of the Apache helicopter. It is Army policy, owever, that the IFTE be the Army standard ATE for providing this capability. ue to a funding shortfall for IFTE and the current fielding of an upgrade to he EETF computer, the Commanding General of AMC requested that an economic nalysis be conducted to compare EETF versus IFTE for the support of Apache.

IMPACT OF THE STUDY: The results of this evaluation do not support transi- tion to IFTE at this time. The EETF with the ECP185(R)2 upgrade is the least cost approach for the peacetime support of Apache. If Army policy were ever changed to buy ATE to wartime requirements, then IFTE would be the preferred alternative. At this time, it is recommended that the Army continue to use the EETF to support Apache. If, however, another ECP of the magnitude of ECP185(R)2 or another buy of EETF's is ever required in order to have EETF remain in the field, then transitioning to IFTE should be reconsidered.

SPONSOR: The Deputy Executive Director for TMDE, Headquarters, U.S. Army Materiel Command (AMC).

PRINCIPAL INVESTIGATOR: Mr. Larry Waggoner, U.S. Army Materiel Systems Analysis Activity, DSN 298-4602.

NAME/ADDRESS/PHONE NUMBER WHERE COMMENTS & QUESTIONS CAN BE SENT: Director, U.S. Army Materiel Systems Analysis Activity, ATTN: AMXSY-LR, Aberdeen Proving Ground, MD 21005-5071. Points of Contact are Mr. Larry Waggoner, Mr. Scott Pridgeon and Ms. Ann Vogt at DSNs 298-4602, 298-7849 and 298-7850 respectively.

DEFENSE TECHNICAL INFORMATION CENTER (DTIC) ACCESSION NUMBER OF FINAL REPORT: The report is sent to DTIC, the accession number is not available.

OTHER THAN SPONSOR, WHO COULD BENEFIT FROM THIS STUDY/INFORMATION? The Program Managers for Apache and Test, Measurement and Diagnostic Equipment and the Ordnance, Missile and Munitions, Center and School.